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An Evaluation of GeoBEST Contingency Beddown Planning Software Using the Technology Acceptance Model

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AN EVALUATION OF GEOBEST CONTINGENCY BEDDOWN PLANNING SOFTWARE USING THE TECHNOLOGY ACCEPTANCE MODEL

THESIS

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AN EVALUATION OF GEOBEST CONTINGENCY BEDDOWN PLANNING

SOFTWARE USING THE TECHNOLOGY ACCEPTANCE MODEL

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Shawn J. Jensen

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Abstract

GeoBEST (Base Engineer Survey Toolkit) is a software program built under contract with the USAF. It is designed to simplify the contingency beddown planning process through application of geographic information technology. The purpose of this thesis was to thoroughly evaluate GeoBEST using prospective GeoBEST users in a realistic beddown planning scenario. The Technology Acceptance Model (TAM) was applied, which measures a prospective user's perceptions of the technology's usefulness and ease-of-use and predicts their intentions to use the software in the future. The evaluation also included a qualitative evaluation of specific software features.

The test group for this thesis was seventy-one Civil Engineering students attending contingency skills training at the Silver Flag training site, Tyndall AFB, FL. The students were given a one-hour interactive demonstration of GeoBEST after which they completed a survey. The students were given the option of using the program for preparation of their assigned beddown plan. Some Silver Flag instructors also completed a separate survey.

The results from the TAM predict that the students were only slightly likely to use GeoBEST for beddown planning in the future. Throughout the course of the research, several features of GeoBEST were identified that limit the program's effectiveness. Some of these were minor irritants, while others were serious design flaws. Recommendations are made for implementation of GeoBEST and creation of training programs for prospective users.

AN EVALUATION OF GEOBEST CONTINGENCY BEDDOWN PLANNING SOFTWARE USING THE TECHNOLOGY ACCEPTANCE MODEL

I. Introduction

1.0 Background

The primary mission of the Air Force Civil Engineer (CE) community is to "provide, operate, maintain, restore, and protect the installations, infrastructure, facilities, housing, and environment necessary to support air and space forces having global reach and power, across the range of military operations." (18) CE duties can be divided into two main categories: peacetime and contingency. Peacetime duties encompass routine, day-to-day tasks required to construct and maintain facilities and infrastructure of established USAF permanent installations. When CE personnel are required to deploy for combat or humanitarian reasons, the contingency skills are utilized. Deployment to underdeveloped foreign countries or other austere locations under less than ideal conditions is the norm. Often, the deployment location is a "bare base."

> With growing reluctance on the part of many third world nations to allow establishment of foreign military bases on their soil, a 'bare base' concept has emerged as a viable solution to a difficult problem – peacetime planning for contingency situations. A bare base, by definition, is a site with a usable runway, taxiway, parking areas and a source of water that can be made potable. It must be capable of supporting assigned aircraft, and providing other mission essential resources such as logistical support and services infrastructure composed of people, facilities, equipment, and supplies. This bare base concept requires mobile facilities, utilities, and support equipment that can be rapidly deployed and installed, and be

available to transform – virtually overnight – undeveloped real estate into an operational air base. (15)

This ambitious mobility concept presents problems and challenges to engineers and planners who have the ultimate responsibility of bare base development (17). Prior to actually deploying, CE planners, with input from other functional experts, produce a plan for "beddown" of the deploying personnel and equipment. Beddown is a highly complex process that includes numerous tasks such as erecting facilities for housing and feeding personnel, providing access to utilities, and construction of work areas. The level of complexity is dependent on many things including the availability and accuracy of information on existing facilities or utilities at the site. As stated previously, the only requirements to meet the criteria of a bare base are a useable airfield and access to a water source that can be made potable. The remaining requirements must be met using either locally available materials and services or packaged deployable equipment (discussed in detail in section 2.2.2). When planning for beddown, the planner must consider numerous factors such as the bare base location, the physical and cultural climate, threat levels, and the needs of the deploying units. The beddown plan is a comprehensive package that includes maps of facility and utility locations, logistics details, preliminary construction schedules, and other pertinent information about the location. It contains the who, what, when, where, and how of the transition from home station to the deployment site. Beddown planning can occur at two levels. Base level planners develop plans that accommodate their own organization (typically a wing) for locations that they are deploying to or expect to deploy to in the future. Higher headquarters planners (typically a Major Command or Unified Command air component) develop more generic plans for multiple sites within their Area of Responsibility (AOR). Planning is classified as either contingency (for imminent deployment) or deliberate (for possible future deployment).

The primary guidance for beddown planning is found in Air Force Pamphlet 10-219 Vol. 5, and the Air Force Handbook 10-222 series. These publications contain detailed information about deployable equipment and facilities, planning factors (ie. requirement estimates based on number of personnel or aircraft such as gallons of water per person), and steps to guide the beddown planning process. Historically, beddown planners have used calculators and drafting tools to develop a plan to accommodate deploying assets and personnel in accordance with the planning factors and siting standards (requirements for facility locations). As new technologies matured, innovations such as Computer Aided Drafting (CAD) and satellite photography have increased the accuracy and consistency in beddown plans. In recent years, computer programmers have taken advantage of spreadsheet and database software to produce programs that automate the beddown planning process. A software program called GeoBEST (Base Engineering Survey Toolkit) is being prepared for employment Air Force wide. GeoBEST is a software program designed to facilitate the contingency beddown planning process through the application of geographic information technology. According to the manufacturer, BTG Delta Research Division (BTG-DRD), GeoBEST allows the planner to actually "build a base" with a computer before deploying. This concept of pre-building a base is claimed by BTG-DRD to provide faster response time in the development of base layout plans for the deployment personnel, equipment, and support facilities. GeoBEST is designed to give the user the ability to view the spatial (physical) domain of a real-world site using available photos, maps or digital images. The planner can then site and match the resources to be deployed with appropriate locations in a configuration that conforms to established standards (10).

GeoBEST is an integral part of the *GeoBase* concept (see section 2.3.5). In the early 1990's, a thorough study was conducted to examine the use of Geographic Information Systems on DoD installations. Two conclusions were drawn from this study: (a) all users within the "battlespace infosphere" have a need for geographic information resources to accomplish their mission effectively and efficiently, and (b) the optimal solution would be to establish a common geographic information framework to improve intercommunication and to maximize the return on its geographic investment (9:12). This common geographic information framework is referred to as the Common Installation Picture, or CIP (see section 2.3.4). In 1998, representatives from the Communications and Civil Engineering community met to discuss methods for better sharing of geographic information resources to make the CIP a reality. The outcome of this and many other meetings was the GeoBase initiative (see section 2.3.5) (39). GeoBase represents a bold paradigm shift in the way the Air Force shares information. When the Air Force deploys, a portion of GeoBase deploys with it in a package called GeoReach. GeoReach is a virtual toolkit of geographic analysis and development tools that includes GeoBEST.

1.1 Problem Statement and Context

GeoBEST is currently in the re-engineering phase. A final version is expected to be released in 2002. When GeoBEST is fielded, how will it be received? Is GeoBEST easy to use? Is it useful? Will contingency beddown planners see increased capability and productivity through use of GeoBEST? Will deploying organizations see improved mission capability when using plans created using GeoBEST? Prior to implementation, a rigorous evaluation of GeoBEST in a realistic beddown scenario is needed.

In September 2000, the Joint Expeditionary Forces Experiment (JEFX 2000) was held "to provide the Air Force a vehicle for experimentation with operational concepts and attendant technologies for enhancing capabilities of the 21st century Expeditionary Aerospace Force." (1) The primary focus of the experiment was 45 initiatives (36 technologies and 9 processes) selected for critical assessment. The CE participants employed two technology packages, JWARN and GeoReach. The JWARN (Joint Warning and Reporting Network) suite of software provides deployed forces with an integrated, comprehensive analysis and reporting tool designed to mitigate the effects of Nuclear, Biological, or Chemical attacks. The GeoReach suite of software is built on ESRI™ ArcView 3.2, a widely used, commercial off-the-shelf Geographic Information System, or GIS (see section 2.3.3). It includes the Contingency Aircraft Parking Planner (CAPP) and GeoBEST. During the experiment, several simulated contingency locations were "built" using GeoBEST and CAPP in scenarios similar to what might be seen at the higher headquarters planning level. The evaluation team consisted of five CE personnel, three officers and two NCO's. Their rank and experience were typical of what is expected at the higher headquarters planning level (50). Overall, GeoBEST was well received by the users and received high marks for its value, validity, and capabilities. Users also provided some recommendations focused on specific design features they felt were deficient. Some major areas of concern were the ability to share files between different workstations, the lack of pre-fabricated standard facility layout templates, some specific software problems, and inadequate Help sections (1). BTG-DRD was provided these results and plans have been made to address deficiencies in the next release of GeoBEST, due in early 2002 (51).

GeoBEST is now ready for further analysis and evaluation before it is implemented Air Force wide. JEFX provided a thorough analysis of GeoBEST, but was insufficient for a complete analysis. The reasons for this are threefold: (a) the sample size of CE planners, five personnel, is very small compared to standard sample sizes needed for thorough experimentation, (b) the level of experience of the JEFX team, higher-headquarters staff, is representative of only one side of the two bodies of beddown planners expected to use GeoReach tools, and (c) the JEFX evaluation, though valuable, did not include consideration of acceptance theory.

1.2 Research Objectives

The objective of this research effort is to conduct a thorough analysis of GeoBEST in a realistic contingency beddown planning scenario using a large sample of base level CE officers and EA's. The results will be in the form of statistical output derived from a proven theoretical model used to predict future usage of new information technology, as well as specific user-provided recommendations for improvements.

1.3 Methodology

The first step in evaluating a software package such as GeoBEST is to gain a full and complete understanding of its capabilities and limitations. Through available training and trial and error, the researcher must become an expert GeoBEST user. A study group is then identified who meet the criteria for the evaluation. The Silver Flag training site on Tyndall AFB, FL provides week-long contingency training courses for base level CE personnel. The managing personnel (Detachment 1, 823rd RED HORSE Squadron) agreed to allow four separate classes to participate in this research, with additional support provided by the Air Force Civil Engineer Support Agency (AFCESA). Standardized surveys based on a conceptual model called the Technology Acceptance Model (13) will be used to gauge the participant's reaction to the software via a series of questions designed to measure the user's perceived ease of use and perceived usefulness of new information technology (IT). These two variables are have been found to be an accurate predictor of intentions to actually use new IT systems (13). Additional questions in the surveys will call for further suggestions and recommendations on specific problems encountered while using the program. These results will then be compiled and forwarded to the contractor and the appropriate AF offices for future integration and modification of GeoBEST. The Silver Flag leadership, AFCESA, and the HAF Geo Integration Office will be provided copies of the results to aid in future integration of GeoBEST into training programs and CE operations.

1.4 Relevance

Air Force Vision 2020 states "We will continue exploring both science and technology and operational concepts, identifying those ideas that offer potential for evolutionary or revolutionary increases in capability. We'll test those ideas rigorously through experimentation to determine which have practical application worthy of development.” (43:6) GeoBEST is one of these revolutionary concepts. The initial beneficiaries of GeoBEST improvement will be the Civil Engineer beddown planners. Improvement of GeoBEST leads to added strength of the GeoReach program, which in turn adds strength and validity to the overall GeoBase concept. Although GeoBase is now primarily a USAF initiative, considerable interest has been expressed for DoD-wide integration (9). All military organizations, regardless of their function, can reap the benefits of consolidated geospatial information sharing.

1.5 Thesis Overview

The remainder of this thesis is divided into the following four chapters: literature review, methodology, results and analysis, and conclusions. Chapter 2 presents information on beddown planning methods and procedures, beddown planning software, geographic information systems, and the GeoBase technologies, including GeoReach and GeoBEST. Chapter 3 outlines methods for evaluating IT, a review of acceptance theory, and the procedures used to create and then implement the data-gathering plan for this research effort. Chapter 4 contains the results of the surveys and output from the Technology Acceptance Model. Chapter 5 provides a summary, outlines recommendations for the future of GeoBEST, lists the shortcomings and limitations of this work, and describes areas for future research.

II. Literature Review

2.0 Introduction

The literature review contains detailed information on topics that are relevant to this research effort. The following subjects are discussed: Civil Engineer mission and responsibilities; beddown planning; geographic science and applications; DOD application of geographic science; the GeoBase concept; and a thorough description of GeoBEST.

2.1 Civil Engineer Mission and Responsibilities

The Air Force Civil Engineer community is guided by the CE mission statement: "Provide, operate, maintain, restore, and protect the installations, infrastructure, facilities, housing, and environment necessary to support air and space forces having global reach and power, across the range of military operations." (18) Civil engineers have always played an integral role in preparing and maintaining air bases. Over the years, civil engineers have:

- Developed, sustained, and recovered wartime air bases
- Planned, designed, and constructed air bases
- Operated and maintained the air base infrastructure
- Protected the environment
- Rescued aircrews and protected resources from fire
- Acquired and fielded new systems and equipment
- Developed and maintained housing communities
- Assisted local communities through civic action programs (42)

The civil engineering skill of interest in this research is contingency air base planning and deve lopment, also know as "beddown" planning. The following section will discuss this concept in more detail.

2.2 Beddown Planning

During war or other contingencies, U.S. forces may be required to operate from several types of installations. These could include main operating bases, collocated operating bases, standby bases, forward operating locations, and bare bases. Some of these types, such as the main operating base, may be substantially developed, whereas others, such as bare bases, may be quite austere from an infrastructure perspective. Figure 2-1 is an example of a bare base developed with expedient deployable assets at Shaikh Isa Air Base, Bahrain during Operation Desert Storm. The rows of facilities are standard 8-10 man fabric-wall shelters used primarily to house deployed troops called TEMPER tents.

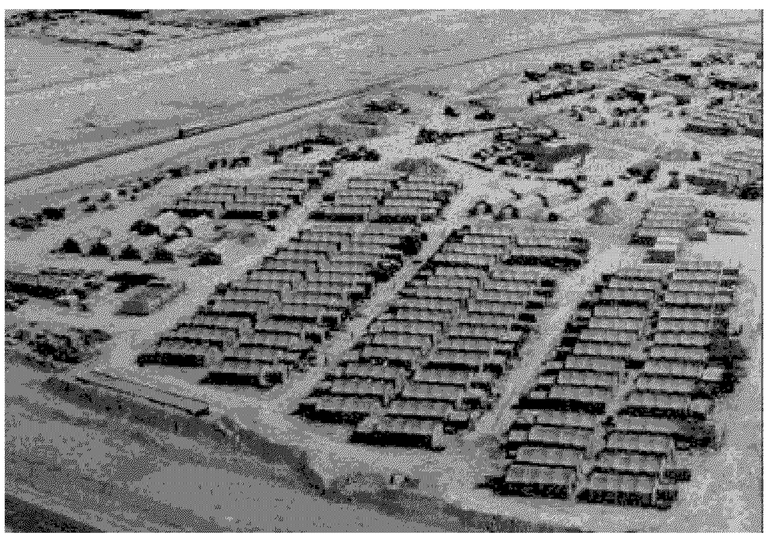

Figure 2-1: Shaikh Isa Air Base, Bahrain (48)

The development of such a bare base is a highly complex process requiring extensive planning.

> Since facilities for use by US forces are limited to non-existent at bare bases, beddown of deploying forces requires a more extensive effort from civil engineers. With the exception of the runway, parking areas, and a nearby source of water, civil engineers may have to start from scratch to provide basic services. A tent city, or suitable substitute, must be erected to shelter deployed forces. Basic utilities (including water, electricity, heat, sanitation) and other services must be established. Aircraft parking areas may need to be expanded, revetments constructed, POL [Petroleum Oil Lubricant] facilities developed, aircraft shelters and maintenance shops erected, and the runway modified or repaired. (16:34)

Planning for deployment can span a range of complexity, from a simple unit-level field exercise, to the enormous logistical and support requirements of Desert Storm. Regardless of how extensively any location has been developed, it must meet one basic criterion—can it support the wartime and contingency missions adequately? Beddown planning addresses a process, which can be used to determine base infrastructure requirements predicated on these wartime mission needs. This serves as a way of ensuring all facility and utility requirements are identified, major siting considerations are considered early, and key survivability and operational features are addressed (17:13).

Under ideal conditions, beddown plans which support operations plans (OPLANs) are accomplished in peacetime by the gaining major command (MAJCOM) or a subordinate unit and documented in the OPLAN, a base support plan (BSP), or a joint support plan (JSP). The level of detail and quality in these plans varies. For short notice deployments and post-disaster support, there may be no time for advance planning. Civil engineers are faced with making an existing plan work or developing a new plan expediently. Whether a plan exists or not, on-site civil engineers must provide site information sufficient to begin the beddown process. They must be able to develop requirements, sort out beddown priorities to get the critical efforts started quickly, and then site, layout, and erect or modify the facilities and utility systems (16:33). Regardless of the level of detail needed for any particular plan, the process of developing it remains the same.

2.2.1 Beddown Planning Process

Beddown planning includes understanding what facilities and utility services incoming units need to perform their mission, finding out what resources are available to satisfy those needs, and then using common sense and available AF guidance to site the facilities and develop solutions to the inevitable problems. The following steps for thorough beddown planning are presented in a logical order, but in situations where time is limited, many events will occur simultaneously. The basic steps are (a) gather the facts, and (b) draft and implement the plan (16:35). Several iterations of the plan may be required before final approval is given. These steps are discussed in more detail in the following sections.

2.2.1.1 Gather the Facts

Beddown planners need to gather and digest a large quantity of information in a short amount of time to develop a good plan. At a minimum, an effective planner should:

- Understand the mission and OPLAN requirements. Find out exactly who is deploying along with their physical and functional requirements. Planning factors (e.g. 50 gallons of water per person per day; see section 2.2.3) will work for most typical deployments, but always be aware of and plan to accommodate special needs.
- Know the threat conditions. Understand the capabilities and as much of the enemy's intentions as possible. For example, if the enemy has the capability of attacking with chemical or biological weapons, there are special facility and personnel requirements to meet these threats.
- Learn the details of any previous planning. There is a high probability that plans have been developed for deployment to the same location at a previous time. Some level of planning may have already been accomplished. Take immediate advantage of any opportunity to save time.

- Gather site geographic data including maps, weather, flood data, etc. Be aware that actual conditions at the site may be drastically different from what is represented in the materials. One of the keys to successful beddown planning is flexibility.
- Find out what facilities and utilities are currently available at the site and their condition. Again, information is only as good as its currency. Facilities that may have been in "good" condition two years ago may be unusable now.
- Determine sources for materials and equipment. The Air Force's inventory of deployable assets (see section 2.2.2) can accommodate most facility and utility requirements for short-notice deployments. Determine which of these assets are available and when they will be transported to the site.
- Learn the commander's priorities. The planners are the functional beddown experts, but prioritization must be coordinated with and approved by higher leadership. Often other branches of service are involved with deployments for contingencies. If this is the case, coordination with the other unit commander(s) must be included in the planning process (16:35).

2.2.1.2 Draft and Implement the Plan

A beddown plan should tell where the deploying units will be located and what must be done to make existing or expedient facilities ready for them. The plan should include a detailed task list and a prioritized scheduled for completing them. Essential to a quality plan is detailed site maps and facility layouts. The decision makers (typically wing or group commanders) must be able to "see" what is being presented. After approval of the final draft, the plan is distributed to all interested parties for implementation (16:36).

Once the plan is finalized, the actual deployment phase begins. Typically, a small ADVON (advance echelon) team is sent to the deployment location ahead of the main body to ensure the site is secure and to note any existing conditions that may not have been accounted for in the plan. This team will also begin preparing the site for the large quantities of personnel and equipment scheduled to arrive soon. Deployment to austere locations with limited resources is the norm. This requires the use of mobile facilities, utilities, and support equipment that can be rapidly deployed and installed to transform the site into an operational air base.

2.2.2 Bare Base Deployable Assets

In the 1950's, military planners developed techniques to prepackage base support equipment. This consisted mainly of tents, field kitchens, medical facilities, power generators, cots, desks, and other equipment. The equipment was bulky, heavy, and required excessive manhours to position and erect. In the 1960's, more equipment was added to the package and some of it was redesigned to make it air-transportable. A new concept for mobility was later developed under which all facilities and equipment would be lightweight, modular, and transportable on a C-130 Hercules cargo aircraft. In the early 1980's, the Air Force purchased a mixture of soft and hard-wall shelters, and eliminated several types of facilities from the inventory that had proven to be maintenance intensive. This new mobile equipment package included several new components including vehicles, engineer equipment, communications gear, medical facilities, unique tactical shelters, and flightline maintenance equipment (17:9).

These new mobile equipment packages were divided into two main groups. Harvest Falcon and Harvest Eagle are the Air Force's primary bare base equipment programs. Harvest Falcon provides complete facilities for long-duration bare base flying and support operations. They are intended for use in Southwest Asia, but may be deployed to any theater if required. The Harvest Falcon assets may be deployed individually or in one of four pre-packaged equipment sets. The 1100-person Housekeeping Set contains all of the assets necessary to beddown a deploying unit of up to 1100 personnel. It contains living quarters, air conditioning units, generators, a kitchen, field laundry, latrines and showers, and some work facilities. The Industrial Operations Set contains base support facilities that enable the base to support itself. It includes additional facilities such as hard wall shelters for use by engineering, supply, maintenance, and several other functions. The Initial Flightline set provides maintenance and operational support facilities with associated utilities for one aircraft squadron. The Follow-on Flightline Set is required for each additional aircraft squadron that is deployed to the same location. Figure 2-2 shows personnel from Ellsworth AFB, South Dakota preparing meals for deployed troops supporting a multi-nation exercise in Egypt. The facility is the Harvest Falcon 9-1 deployable dining facility. The food services team fed 1,100 military personnel three hot meals daily (23).

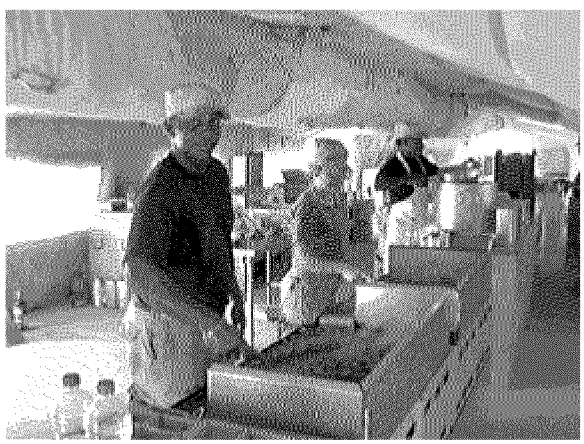

Figure 2-2: 9-1 Deployable Feeding Facility (23)

Harvest Eagle mobile equipment packages provide facilities for bare base living and working or for supporting additional personnel at an existing location, but do not provide many flightline support assets. They are intended for use in Europe or the

Pacific, but may be deployed to any theater if required. Harvest Eagle assets may also be deployed individually or in one of three sets. The 550-person Housekeeping Set, a Utilities Set, and a Cold Weather Set. (47:3) Figure 2-3 shows personnel from RAF Lakenheath, United Kingdom erecting Harvest Eagle TEMPER tents (personnel housing) in preparation for a NATO operation in Yugoslavia (3).

Figure 2-3: TEMPER Tent Erection (3)

With the acquisition and integration of the Harvest Falcon and Eagle mobile equipment sets, the beddown planning process has evolved to accommodate these changes. The following section discusses some recent applications of information technology that have helped to automate the beddown planning process.

2.2.3 Beddown Planning Automation

The beddown planning process is heavily dependent on calculations and estimates derived from planning factors. For example, when estimating electrical requirements, the planner multiplies the number of personnel at the location by the planning factor, 2.7 kilowatts per person (17:191). This lets the electricians know the number and type of generators needed to meet the requirement and it will also drive other requirements such as fuel and personnel to set up and maintain the equipment. Similar planning factors are available for other utility estimates, facility square footage, aircraft parking, covered storage, and many others. Historically, the beddown plan was created using these basic planning factors, drafting tools, and whatever paper maps or photographs were available. This has become known as the "stubby-pencil" method. The advent of electronic calculators, computers, and Computer Aided Drafting (CAD) software allowed for faster calculations and more accurate maps. In recent years, computer programmers have taken advantage of spreadsheet and database software to produce programs that automate the beddown planning process. Two examples discussed here are the Automated Airbase Contingency Estimator (AutoACE), and Air Force Bare Base PlanMaster. The focus of this research, GeoBEST, will be discussed in section 2.3.6.

2.2.3.1 Automated Airbase Contingency Estimator

In the mid-1990's, five CE officers from Barksdale AFB, Louisiana and Holloman AFB, New Mexico combined their knowledge of beddown planning methods and spreadsheet software to produce the Automated Airbase Contingency Estimator, or AutoACE (33). Figure 2-4 is a screenshot of AutoACE in use. This screen is used to calculate the number of CE personnel required to complete the beddown tasks indicated in other parts of the program. Other screens are used to enter basic information about the location, the number and type of aircraft expected at the location, materials required to complete necessary construction, and several others.

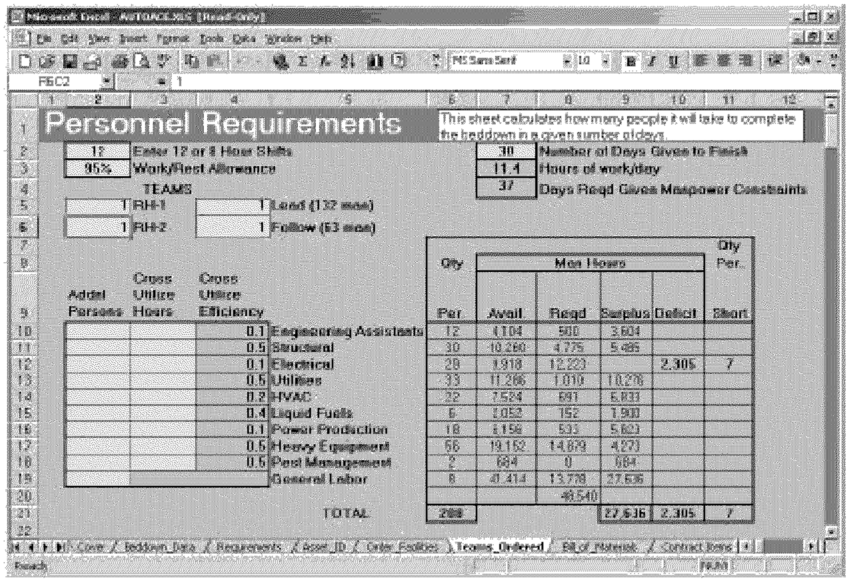

Figure 2-4: AutoACE

Created in Microsoft™ Excel, AutoACE is based on planning factors and other guidance found in AFPAM 10-219 and AFH 10-222. It consists of thirteen formatted worksheets for calculating airfield, facility, utility, and personnel requirements. It also contains information about deployable assets (Harvest Falcon and Harvest Eagle) and Air Force aircraft (dimensions, weight, etc.). AutoACE allows the user to interactively select desired facilities and utilities. If the requirements entered into AutoACE cannot be met using indicated personnel and equipment, the program notifies the user to order more assets and recalculates the timeline. To enhance user-friendliness, the program uses a standardized color scheme. All user input areas are shaded yellow. AutoACE is a capable program for performing calculations and determining requirements, but it currently has no capability for viewing, creating, or modifying maps or drawings.

2.2.3.2 PlanMaster

In 1997, under contract with the USAF, Decision Dynamics, Inc. released a beta version of their bare base planning program called PlanMaster (14). Figure 2-5 shows a screenshot of PlanMaster in use. This particular screen is used to calculate the effects of climate factors, fatigue, and morale on personnel effectiveness. Other screens are used to input specific beddown information and to calculate required personnel and equipment.

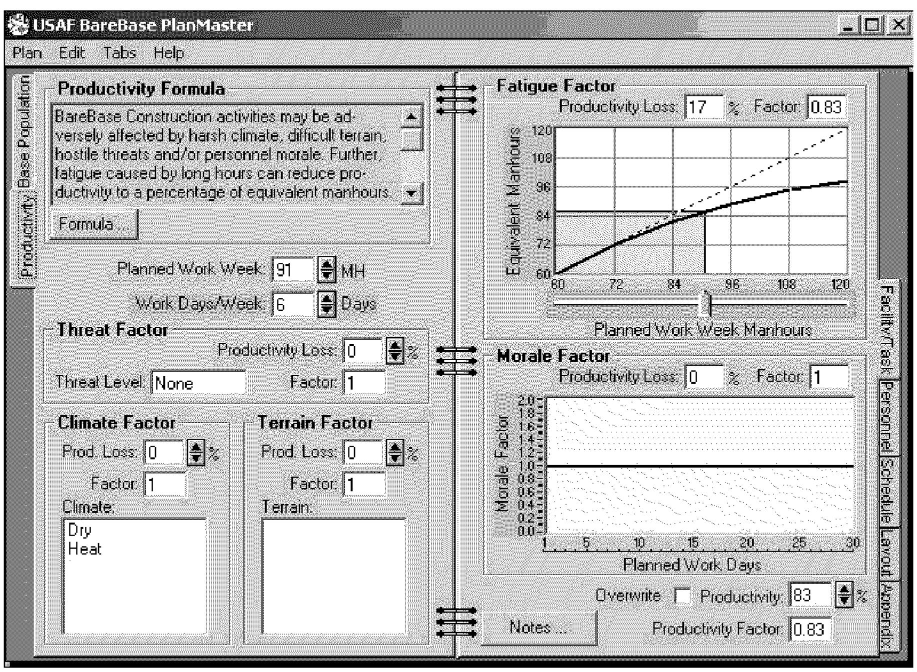

Figure 2-5: PlanMaster

The PlanMaster user interface is designed to appear and function like a notebook. To create a new bare base plan, the user makes selections to define mission and location profiles. The user identifies the number and type of aircraft to be supported by the base. Development of a location is enhanced by the selection of built-in climate and terrain options. Settings for the anticipated threat level are used to assess construction priorities and facility hardening requirements. PlanMaster allows the user to select facilities required for the bare base site from pre-defined deployable asset sets. Using the planner's input, the program uploads the relevant database information and generates a customized construction management plan. The program includes three generic base layout maps with basic facility and utility locations, but does not allow for modification of these maps or creation of new maps. Literature accompanying the program indicates that future versions of PlanMaster will include this capability. As of this writing, no follow-on funding has been provided to the contractor for further development of PlanMaster (14).

As exhibited by AutoACE and PlanMaster, the ability to make calculations and develop timelines for beddown planning has been aided by use of computer information technology. However, neither program includes the ability to create or view maps of the beddown location. This must be accomplished using other means. The methods range from "stubby pencil" drawing of assets on a paper map to the use of more sophisticated drafting software programs and geographic technologies. The following section discusses basic geographic science, some specific innovations in the field, and how these advances have been applied to the military in general and more specifically to the field of beddown planning.

2.3 Geographic Science and Applications

The geographic discipline focuses on emphasizing the “where” in describing events or conditions. Roughly 80% of all information has a geographic basis. The earth offers a single frame of reference allowing the geographer to fix any given occurrence to a single location and then study spatial (physical) relationships. The surge in modern computing capabilities has catapulted the geographic discipline forward by enabling rapid collection and analysis of massive data stores to reveal hidden patterns. Three specific innovations have together served as the key components of this geographic revolution: the Global Positioning System (GPS), remote sensing, and Geographic Information Systems (GIS) (9:4).

2.3.1 Global Positioning System

Trying to figure out where you are and where you're going is one of man's oldest pastimes. Navigation and positioning are crucial to so many activities and yet the process has always been quite cumbersome. As the need for greater and greater weapons delivery accuracy increased, the U.S. Department of Defense recognized the need for a global targeting system. The result is the Global Positioning System (GPS) (41). GPS is made possible by a system of 24 orbiting satellites and earth-bound receiving devices used to compute positions on the earth (24). Figure 2-6 is a diagram of how three satellites are used to “triangulate” a location on the earth’s surface and some of the gear used to receive signals from the satellites and process GPS data.

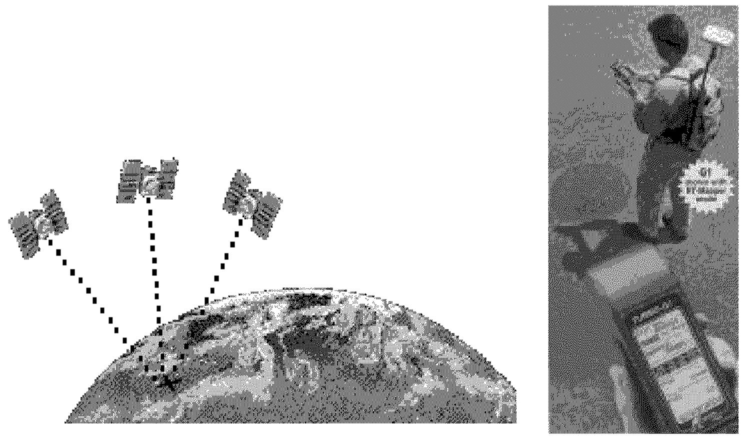

Figure 2-6: Global Positioning System (41)

With commercially available hand-held receivers, users worldwide can now easily pinpoint locations on the earth's surface to within a few meters (latitude, longitude, and altitude). GPS receivers have been miniaturized to just a few integrated circuits and are becoming very economical, making the technology available to virtually everyone. The value of GPS, however, is enhanced greatly when used together with high-resolution imagery now provided by advances in the field of remote sensing (9:4).

2.3.2 Remote Sensing

Remote sensing, in its most basic form, is acquiring information about an object without contacting it physically (24). The human eye is a perfect example. It continually gathers information from surroundings objects with any physical contact. To the geographer, remote sensing usually refers to the technology of acquiring information about the earth's surface (land and ocean) and atmosphere using sensors onboard airborne (aircraft, balloons) or spaceborne (satellites, spacecraft) platforms (34). Commercially available imaging technology has now replaced analog photography with a digital process permitting discrete analysis of images acquired at incredible distances. Today, airborne commercial sensors collect imagery with less than one-meter resolution across the visible, infrared, and microwave regions of the electromagnetic spectrum. The recent advances in both GPS and remote sensing are put to their most effective use when integrated with modern Geographic Information Systems (9:5).

2.3.3 Geographic Information Systems

"GIS is a system of computer software, hardware, data, and personnel to help manipulate, analyze, and present information that is tied to a spatial (physical) location." (49) In the strictest sense, GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations. Many also regard the total GIS as including operating personnel and the data that go into the system (23). Figure 2-7 contains two simple graphical representations of a Geographic Information System and some of its applications. The real world is divided into meaningful "layers" to sort and organize spatial information.

2.3.4 DoD Application of Geographic Information Technology

Within the DoD, the initial wave of GPS, remote sensing, and GIS investment came from the ranks of civil engineers and environmental managers for use in creating base maps, managing weapons ranges, plotting groundwater pollution contours, and several other applications. The promise of tremendous mission benefits from geospatial information technology spurred countless defense installations to invest heavily in these technologies in the late 1980's. However, virtually no attention was given to sharing this information across the installation (9:10).

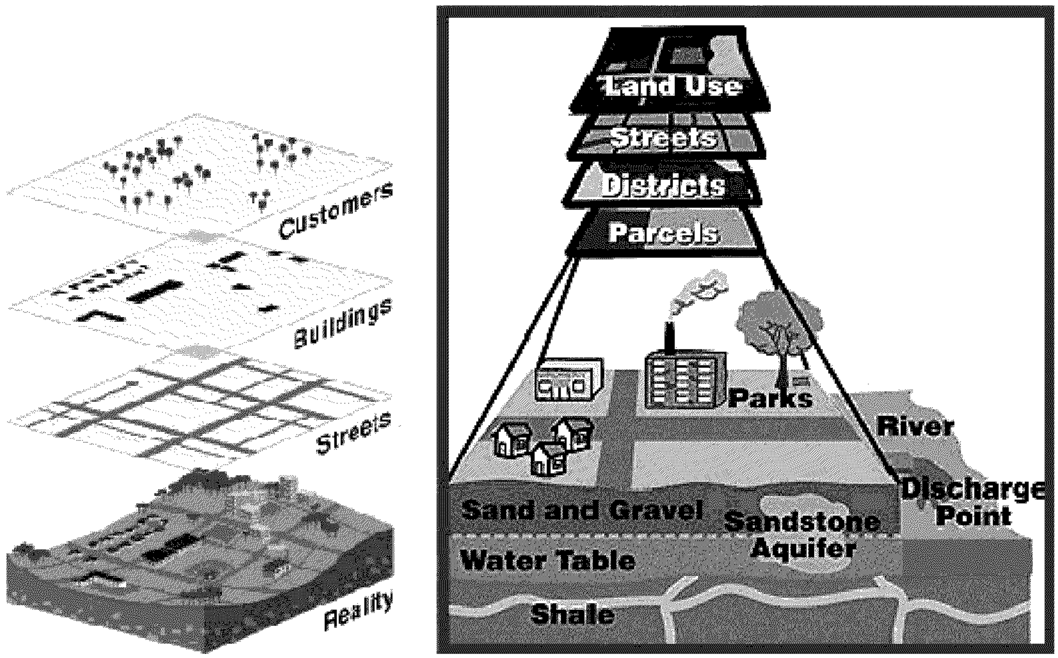

Figure 2-7: Examples of GIS Application (49)

Sharing geographic information across the installation has many potential benefits. At the base level, reports of information mishaps are plentiful. For example, a civil engineering unit spends thousands of dollars building a new parking lot, but before the stripes are painted, a communications contractor trenches through the asphalt to lay fiber optic cable. At another site, four separate GIS initiatives are pursued within the same wing to support environmental, natural resources, civil engineer, and weapons safety missions. At another site, a contracted backhoe operator discovers too late where a new natural gas line was laid due to a lack of accurate maps (9:11).

In 1992, the DoD sponsored a three-year study of geographic information technology adoption on defense installations, visiting over 50 sites. The following are two of the conclusions resulting from this study: (a) all users within the "battlespace infosphere" have a need for georeferenced information to accomplish their tasks in the most efficient and effective manner; and (b) the optimum solution would be to establish a common geospatial framework for all warfighters so the defense department can improve intercommunication and maximize the return on its GIS investment (9:12). The common geospatial framework would result in a concept called the Common Installation Picture, or CIP. The CIP is proposed to be an effective means of abating the situational confusion at the base level. Currently, each functional unit collects data relevant to its mission tasks. They filter their data through their individual geographic reference framework, and commanders are left with a poor understanding of the aggregated mission situation. This situation is illustrated in Figure 2-8. The eleven organizations shown represent the dozens of functional areas found at any given installation. Information is filtered through independent reference frameworks, resulting in situational knowledge significant to that particular organization. When the filtered information is funneled up the chain of command, the result is a conglomeration of inputs that produces a usable, although obscure and limited decision environment.

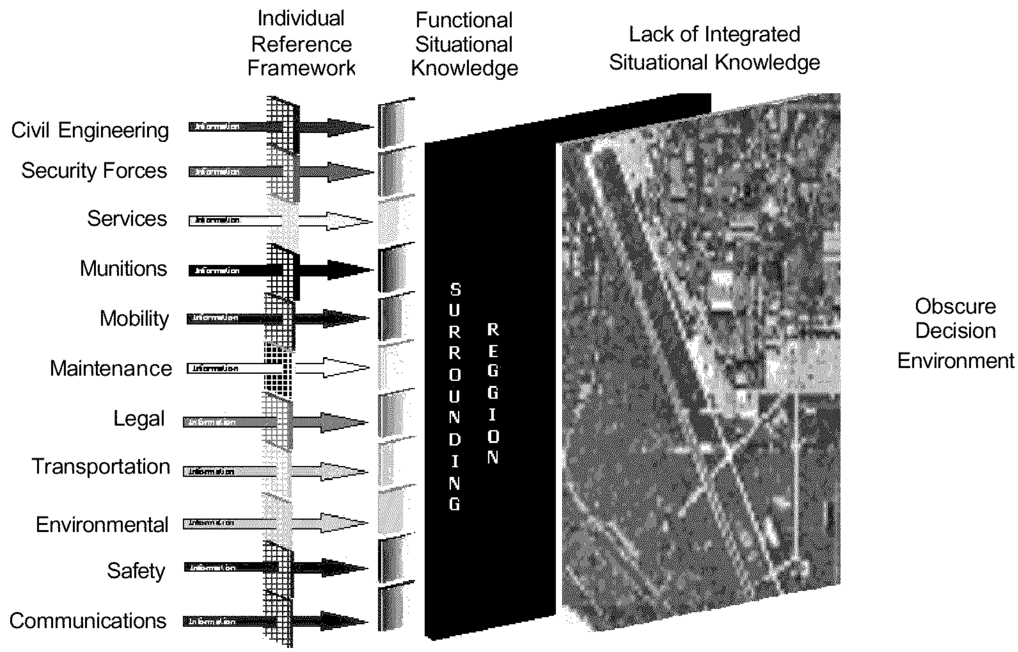

Figure 2-8: Pre-CIP Base Information Sharing (9:17)

A common reference framework consolidates the various functional data and provides this essential aggregated mission situation thereby producing the Common Installation Picture, as illustrated in Figure 2-9. Decision makers are provided with a clear, aggregated view of the decision environment (9:17).

Thanks to the Air Force's investment in installation-wide communications infrastructure, virtually all nodes on the base network could gain access to the CIP. All that is needed is the common geospatial framework, or what has become known as "GeoBase."

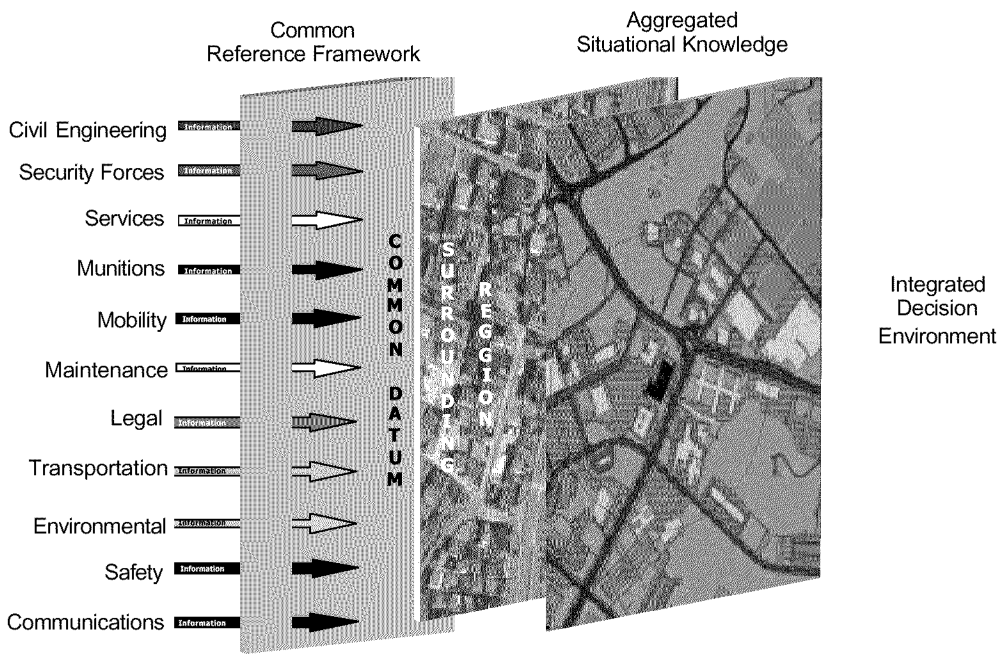

Figure 2-9: Common Installation Picture (CIP) (9:18)

2.3.5 GeoBase

In the fall of 1998, representatives from the communications and information management communities met with civil engineer agencies to explore how the two functional missions could better share geospatial information resources. The technology and the infrastructure were available to implement the CIP to make collaborative geospatial information sharing a reality. The desired outcome of the GeoBase effort is to ensure each USAF installation has the organic capacity to access, exploit, and maintain one geospatial information infrastructure supporting multiple mission needs (39).

Using available commercial-off-the-shelf (COTS) computer hardware and software, GeoBase is designed to make the CIP a reality. It is not a "system" in the sense of a software package such as Microsoft™ Office, but is more of a concept based on integrating multiple data sets into a common architecture using proven geospatial technology. The potential applications of GeoBase are numerous. It can be used to provide daily mission support for facility management, airfield operations, explosive safety siting, and communications maintenance. Emergency services can use built-in tools to plot cordons around emergency sites and reroute traffic flow. Airfield obstructions can be managed to a higher degree of accuracy providing aircrews with a better visualization of the airfield. Communications cables and utility lines can be located to a higher degree of accuracy when performing construction or maintenance, preventing costly damage and unscheduled outages. All base users would be working from the same data sets, ensuring that the current information is up-to-date and accurate. Figure 2-10 is an example of a GeoBase emergency response tool in use at Moody AFB, Georgia. Automated screens prompt users for information about facility numbers, size of cordon needed, traffic rerouting, and several other features.

With FY02 funding, it is expected that GeoBase foundation data and core applications can be acquired and implemented at all USAF installations within two years (10:13). The next step will be DoD-wide implementation and further development of the GeoReach concept, which takes the functionality of GeoBase and adds a virtual toolkit of planning, analysis, and communications software for use at a bare base or forward operating locations. GeoReach is essentially a deployable version of GeoBase and includes the Contingency Aircraft Parking Planner (CAPP) and a bare base planning tool called GeoBEST, which is the focus of this research effort. The following section describes GeoBEST in detail.

Figure 2-10: GeoBase Emergency Response Tool

2.3.6 GeoBEST

GeoBEST (Base Engineering Survey Toolkit) is a PC-based GIS application designed to give users the ability to view the spatial extent of a selected location. The user can match the resources to be deployed with the appropriate locations in a spatial configuration that conforms to established siting standards. GeoBEST was created by BTG Delta Research Division of Niceville, Florida under the name Bare Base Conceptual Planning System (BBCPS). It was later renamed GeoBEST to help identify it as a part of the GeoReach program. Initially developed for use in the Pacific Air Force (PACAF) theater of operations, GeoBEST provides deployment planners with an automated, interactive, computer-based tool for rapid development of base layout plans. This can be applied to any location for which imagery is available. The application allows the user to import various types of imagery and locate each of the facilities required at the location in response to a defined scenario. The following is a more detailed description of the program including some images of GeoBEST in use.

Like GeoBase and GeoReach, GeoBEST is based on commercial-off-the-shelf software. The user interface, created with Microsoft™ Visual Basic, interacts with ESRI™ ArcView and a Microsoft™ Access database. The GeoBEST interface consists of a split screen, with the Visual Basic window on the left and the ArcView window on the right, as shown in Figure 2-11. Both windows are opened by running the GeoBEST executable file and both are closed by closing the GeoBEST window.

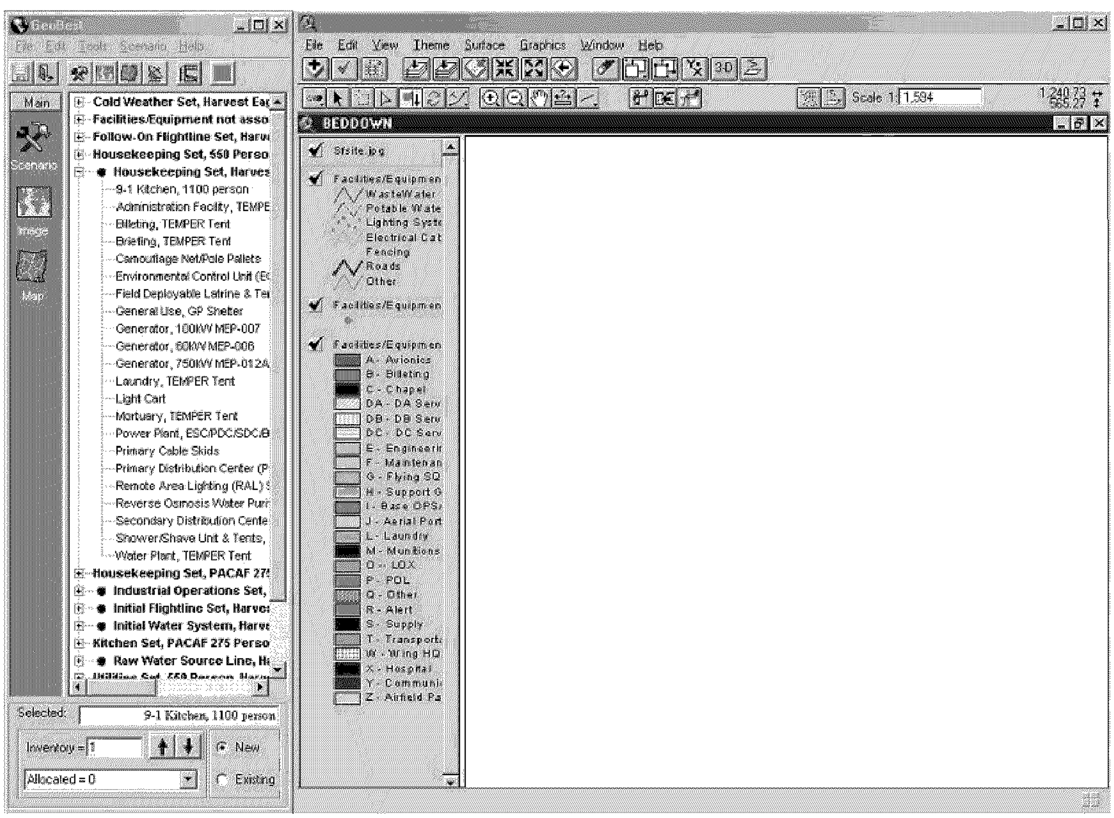

Figure 2-11: GeoBEST User Interface

When working with GeoBEST, the user's work is saved as a "scenario." Each scenario stores the data sets (imagery, assets, etc.), inventory and number of allocated assets, and any maps or reports created and saved by the user. Users initially have the option of either opening an existing scenario or creating a new one. The current version of GeoBEST comes with eighteen pre-made scenarios (without background imagery) based on the dispersed facility layouts shown in the Bare Base Conceptual Planning Guide, AFPAM 10-219, Vol. 5, Attachment 15 (17:274). These can be used as a separate scenario or imported as templates into other scenarios. When creating a new scenario, the user may elect to create a blank scenario (inventory and deployment packages set to zero) or use the scenario wizard. Blank scenarios are primarily intended for creation of new templates. The scenario wizard walks the user through the development of a scenario that will generate the recommended Harvest Falcon or Harvest Eagle asset kits based on the entry of a base population and/or selected aircraft types and quantities. The user has the option of accepting the recommended quantities or modifying them if the exact quantities are known. If the scenario wizard is used, GeoBEST automatically calculates the number of individual assets needed based on the population. Again, the user may accept these quantities or modify them as needed.

Scenarios in GeoBEST may include site drawings and/or imagery, or the user may create layouts consisting only of the Harvest Falcon/Eagle assets. GeoBEST has the capability of integrating a variety of different data sets, including AutoCAD files, shape files, Intergraph Design files, image formats (jpg, bmp, tif, sid, gif, etc.), GPS data sets, and many more. Each data file is added as a "theme," which could be thought of as a layer. The different themes may be displayed or hidden as needed (see section 2.3.3).

The GeoBEST database stores the dimensions of each deployable asset (length, width, and height) in terms of its footprint (ie. the rectangular space it occupies as opposed to its actual shape). Linear assets (eg. water pipe, electrical cable, etc.) are drawn using unique line colors, types, and weights. Figure 2-12 shows an open scenario with allocated assets and a bitmap image as the background theme. The groups of assets shown are billeting (housing) TEMPER tents and the large asset on the right is a Harvest Falcon 9-1 Kitchen.

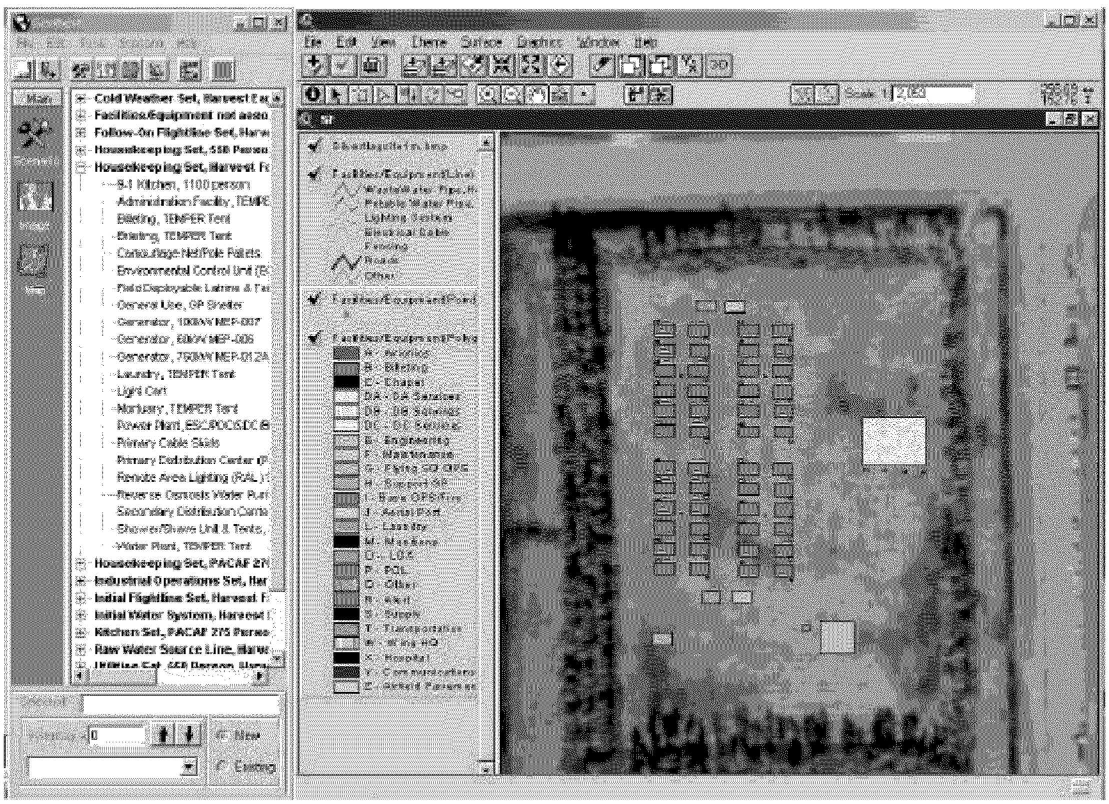

Figure 2-12: Open GeoBEST Scenario

In order to ensure the allocated assets are scaled correctly, the user must specify the map units. GeoBEST is capable of working in meters or feet. ArcView has the capability of scaling image files based on the image resolution or the dimensions of an object displayed in the image (dimensions of a building or runway). Feature data, such as AutoCAD drawings, are displayed using whatever units they were created in. GeoBEST allows the user to overlay multiple data sets in a process called image registration. For example, an AutoCAD drawing could be overlaid onto a photograph. The image file will be rescaled to match the feature data. ArcView does not have the ability to rotate the imagery or data sets. The user must therefore ensure that each file has the same orientation when attempting image registration.

Once the Harvest Falcon/Eagle assets have been added to a scenario, they may be copied, grouped, rotated, or deleted. The GeoBEST inventory tracker monitors the quantities of each asset as they are modified. GeoBEST Constraints Analysis tool has the ability to analyze groups of facilities to determine if they meet the distance requirements for non-dispersed and dispersed layouts. For example, there should be at least 12 feet between individual billeting TEMPER tents in a non-dispersed layout. The Area Analysis tool is used to determine the quantity of a particular asset that will fit within a designated area.

GeoBEST has the ability to store and display four types of metadata (multimedia information) for each of the individual assets: text, image, video, and audio. About 100 text files and 100 images of various assets are included with the current version of the program. GeoBEST allows the user to add these files for individual assets if they are available. Figure 2-13 is an example of text and image metadata for a Harvest Falcon MEP-012 generator. These are included with the current version of GeoBEST.

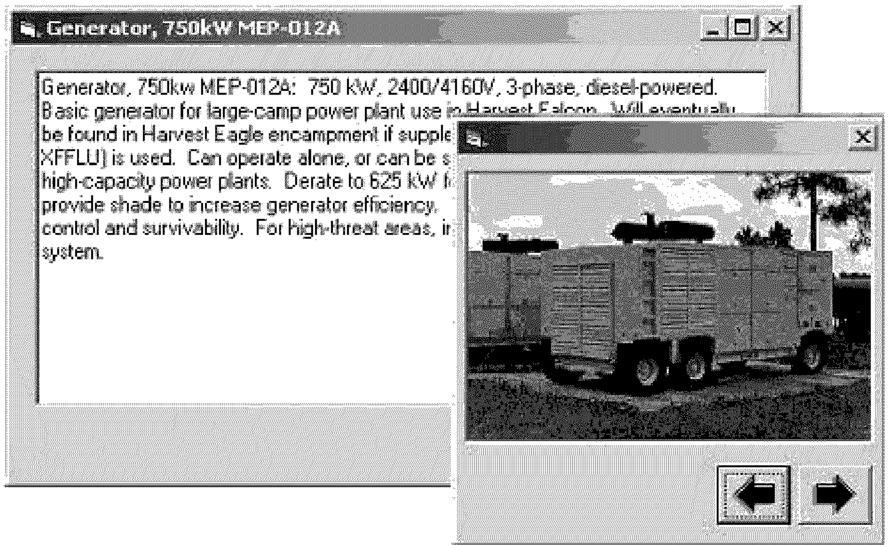

Figure 2-13: Metadata Text and Image for MEP-012 Generator

GeoBEST has the ability to display scenarios in a three-dimensional format. The user can pan, zoom, or rotate the 3D image to view particular areas or select a continuous "fly-around" view. The current view can be saved as a jpeg or bitmap image for importing into documents or presentations. Figure 2-14 is an example of a 3D view, showing the scenario displayed in Figure 2-12.

The GeoBEST report generator allows the user to create custom reports. Currently, five types of reports are offered. These include All Scenarios, Facilities/Equipment Inventory, Deployment Package Inventory, Labor Requirements, and Power Requirements (7).

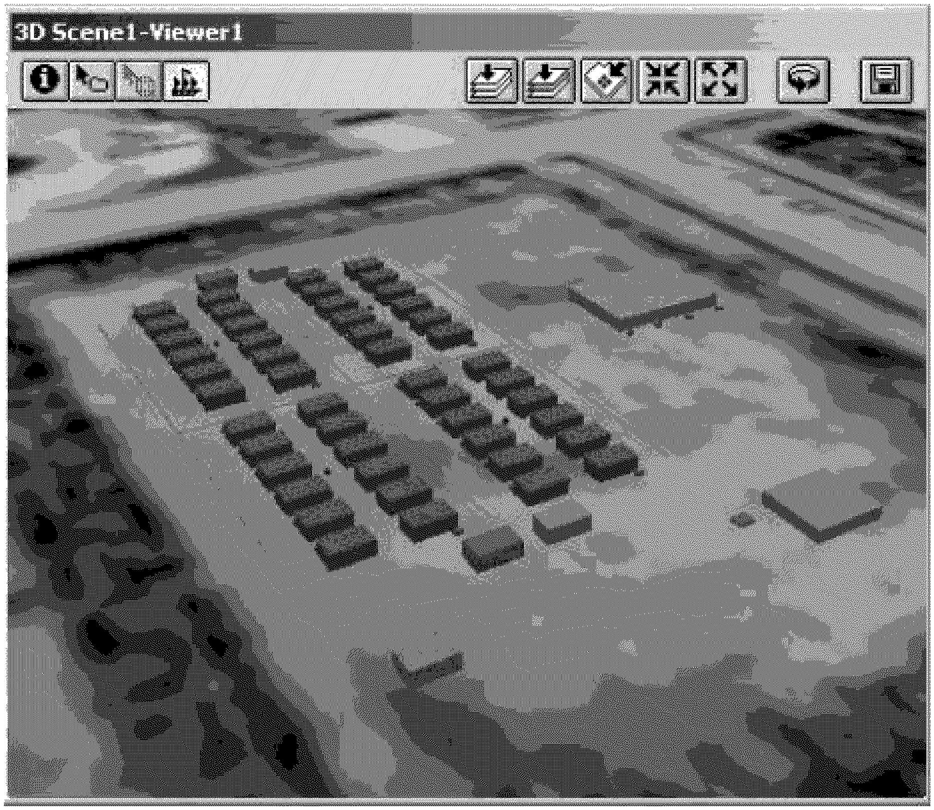

Figure 2-14: Scenario 3D Viewer

- All Scenarios: This report lists all scenarios that have been created and their general information, which includes the scenario ID, name, population, directory location, date, created, date modified, and the user who created it.

- Facilities/Equipment Inventory: This report contains information regarding the current scenario assets, to include asset name, number inventoried, number allocated, and number recommended. The report can display all assets in the selected deployment packages or just the currently allocated assets in the view.

- Deployment Package Inventory: This report contains information regarding the deployment packages related to scenarios that were selected during the initial creation of the scenario. The report includes the asset name and which deployment package it belongs to. This report can only display all assets in the selected scenario.

- Labor Requirements: This report contains information regarding the labor hours required to assemble or erect each asset. The report includes asset name, number allocated, required labor hours, total required labor hours, and a description of the type of labor required. This report can display all assets in the selected deployment packages or just the currently allocated assets in the view.

- Power Requirements: This report contains information regarding the power required per asset in kilowatt-amperes. This report includes asset name, number allocated, normal power voltage, total normal power voltage, air conditioning voltage, and total air conditioning voltage. This report can display all assets in the selected deployment packages or just the currently allocated assets in the view (7).

All of the information used by GeoBEST is contained in a Microsoft™ Access database. GeoBEST includes the ability to manage this database. Users can modify information about the deployment kits, modify or add/delete individual assets, adjust the number of personnel associated with each type of aircraft, and correct any deficiencies or inaccurate information.

Built into GeoBEST is a generic thirty-day timeline called Scheduler. Using a color-coded priority scheme, assets are divided into task disciplines. For a particular task, the work is broken down by Air Force Specialty Code (AFSC). For instance, installation of a mobile aircraft arresting system is a first priority, it requires at least four Power Production personnel (3EX02) to install, and it should be completed by day three. Figure 2-15 shows Scheduler in use.

GeoBEST takes some of the functionality of previous beddown planning programs such as AutoACE and adds the capability of integrating multiple image and data formats. Whether or not the program will be perceived by its intended users as useful or user-friendly is the subject of this research effort. The evaluation accomplished by the Joint Expeditionary Forces Experiment 2000 (see section 1.2) and results from this research effort will be used to streamline the product and prepare it for Air-Force-wide employment beginning in 2002, including the creation of essential training programs.

JEFX 2000 provided a thorough evaluation of GeoBEST, concentrating on eight separate factors: maturity/viability, interoperability, availability, human factors, interaction, accuracy, completeness, and value added (1). Design features of the software were examined as well as how the program fit into the Air Force's plan for advancement of the GeoBase concept (sec. 2.3.5). The primary focus of this research will be an examination of GeoBEST using an information technology evaluation approach called Acceptance Theory (see section 3.1.1). The secondary focus will be to gather additional feedback from users on specific design features.

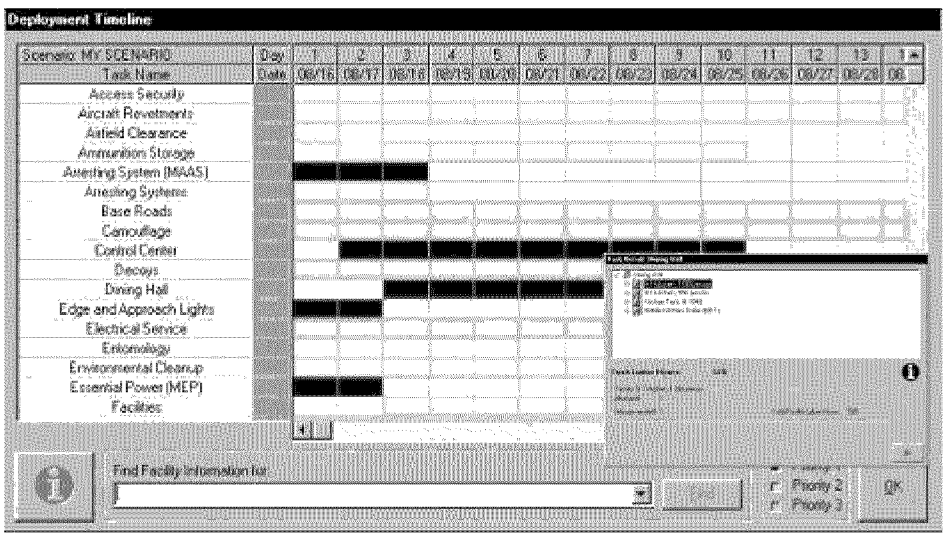

Figure 2-15: Scheduler

2.4 Summary

This chapter presented a background of CE mission and responsibilities, beddown planning methods and procedures, and two examples of how IT has been applied to the beddown planning process. Geographic science and its components and applications were presented to provide an understanding of the GeoBase concept and its subprogram, GeoReach. Finally, a thorough description was provided for GeoBEST and the JEFX evaluation. The following chapter describes in greater detail methods for applying Acceptance Theory and the plan for implementing this theory in an evaluation of GeoBEST.

III. Methodology

3.0 Introduction

The purpose of the methodology chapter is to outline the process used to conduct the GeoBEST evaluation. Three evaluation methods are discussed and the Technology Acceptance Model (TAM) (13) is found to be the most appropriate for this research. Implementation of the TAM requires seven steps: (a) identify an appropriate study group, (b) develop an evaluation plan, (c) design surveys, (d) test the plan, (e) implement the plan and gather data, (f) analyze the data, and (g) draw conclusions. Each of these steps is discussed in greater detail.

3.1 Software Evaluation

Software evaluation in its most basic form asks one simple question: "Does the software meet the needs of the intended user?" With the complexity of modern computer programs, a yes/no response to this question does not provide any meaningful information that programmers could use to refine their products. More detailed questions are needed. How well does the software meet the user's needs? Is the software easy to use? Is the software useful? Is using the software a pleasant experience? How well does the software interact with other programs? The potential list of questions is endless. JEFX 2000 (see section 1.2) provided answers to many of these questions for GeoBEST. This research will take the evaluation of GeoBEST one step further and apply an IT evaluation approach called Technology Acceptance Theory.

3.1.1 Acceptance Theory

The ultimate goal of any information technology is to increase the performance level of the user through the use of this technology. With the rising cost of new technology development and reengineering, there is a need for a way to predict future usage of information technology by its intended users. Technology acceptance modeling provides methods for predicting user behavior. Three models have been developed and successfully used to predict actual system use by measuring the user's perceptions toward that system. These are the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), and the Theory of Planned Behavior (TPB). Following is a discussion of these models and rationale for selection of the Technology Acceptance Model for use in this research.

3.1.1.1 Theory of Reasoned Action

In social psychological research, theorists seek to identify the determinants of behavior within the individual rather than the technology under review. Fishbein and Ajzen's Theory of Reasoned Action (TRA), shown in Figure 3-1, has been used to more fully develop how user beliefs and attitudes are related to individual intentions to perform (22). The different text blocks in the diagram represent the model variables and arrows between the blocks can be interpreted as "influences…" or "leads to…" For example, the Subjective Norm influences Behavioral Intention, which leads to the actual Behavior (21:9).

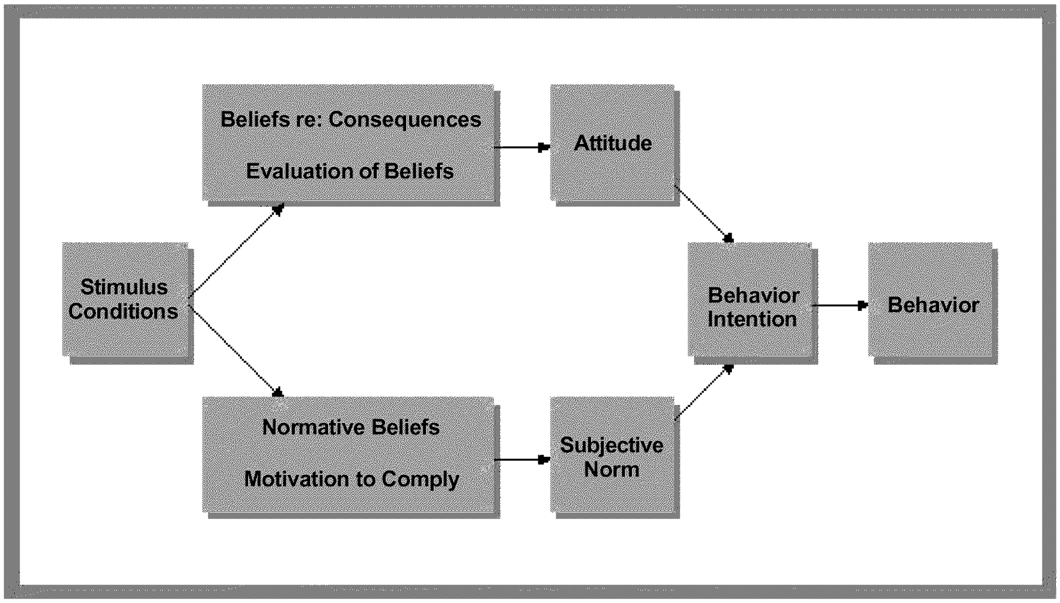

Figure 3-1: Theory of Reasoned Action (45) (29)

The Theory of Reasoned Action is a model used to predict people's behavior. Stimulus Conditions includes all environmental factors that are beyond the direct control of the individual. According to TRA, an individual's behavioral intention is affected by two factors. One is the attitude toward the behavior, or the person's beliefs that the behavior leads to certain outcomes and his evaluations of these outcomes. The second is the subjective norm, or the person's beliefs that specific individuals or groups think he should or should not perform the behavior and his motivation to comply with the social pressures. The TRA forms the basis for the Technology Acceptance Model ultimately selected for use in this study.

3.1.1.2 Technology Acceptance Model

The Theory of Reasoned Action is useful for predicting behavior in general but the Technology Acceptance Model (12) has shown to be more useful for predicting user acceptance of information technology such as computers and computer programs. The Technology Acceptance Model's (Figure 3-2) primary purpose is to predict user acceptance based on two constructs: *perceived usefulness* and *perceived ease of use*.

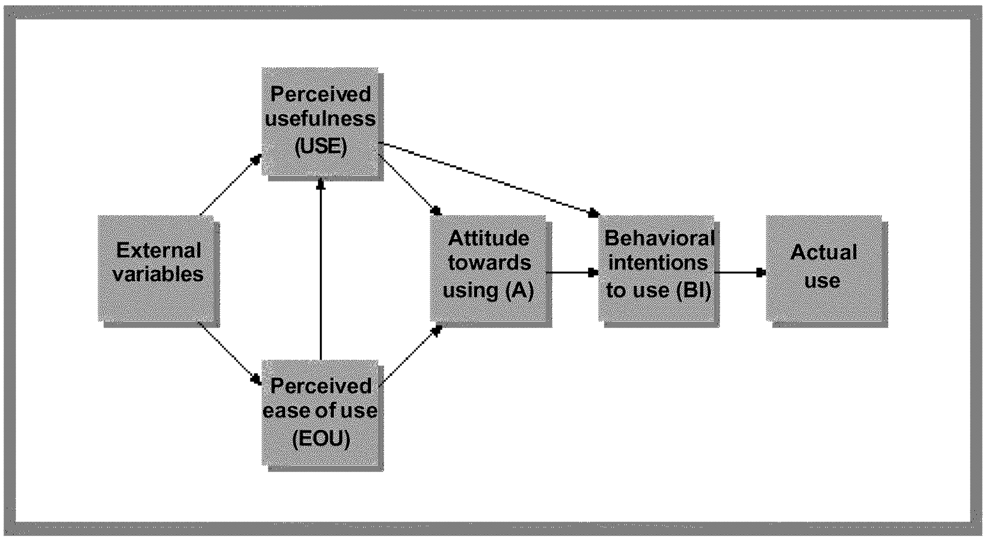

Figure 3-2: Technology Acceptance Model (13)

Perceived usefulness (USE) is defined as the degree to which a user believes that using the system will enhance his or her performance. A system perceived as useful would be one that a user believes would have a positive use-performance relationship (12:320). Perceived ease of use (EOU) is defined as the degree to which the user believes that using the system will be free from mental or physical effort (29:59). Given two systems, a user will rate the system he or she finds easier to use as having a higher ease of use score. In addition to its direct affect on behavioral intention, perceived ease of use has been found to have a direct influence on perceived usefulness as well. Making a system easier to use will make it more useful, however the opposite is not necessarily true. External variables include any factors not explicitly included in the model such as specific system design features (13). The Technology Acceptance Model has been used successfully in numerous studies. Davis, Bagozzi, and Warshaw successfully predicted use of a word processing program using a class of MBA students. (13) Dillon and Morris predicted use of a web browser program using a university computer science class. (29) For additional examples and discussion see Davis, 1989 (12), Davis, 1993 (11), Venkatesh and Davis, 1996 (44), Venkatesh and Davis, 2000 (45), Szajna, 1996 (37), Jackson and others, 1997 (26), Lucas and Spitler, 1999 (27), and Venkatesh and Morris, 2000 (46).

3.1.1.3 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) was adapted from the Theory of Reasoned Action by Icek Ajzen in 1985 (2). The TRA (sec. 3.1.1.1) includes two variables which lead to behavioral intention, evaluation of beliefs and motivation to comply. The TPB model (Figure 3-3) adds a third antecedent of intention to the TRA model, perceived behavioral control.

Perceived behavioral control is a person's belief in the availability of assets needed to complete the behavior (38). The literature provides comparisons of the TAM and TPB, though the results are mixed. In one instance, both the TAM and TPB were tested and it was found that although TPB predicted user intention, it did not provide as complete an explanation of intention as did TAM. It was also noted that TAM was easier to apply (28). Taylor and Todd (1995) conducted a study concluding that TAM was a slightly better predictor of usage but that TPB provided a more complete (albeit slight) understanding of the determinants of intention ($R^2 = 0.57$ for TPB and 0.52 for TAM)

(38). The TPB model adds seven more variables to increase its predictive capability 2% over TAM. It was concluded that if the goal is to predict information technology usage, TAM is the better of the two models (43).

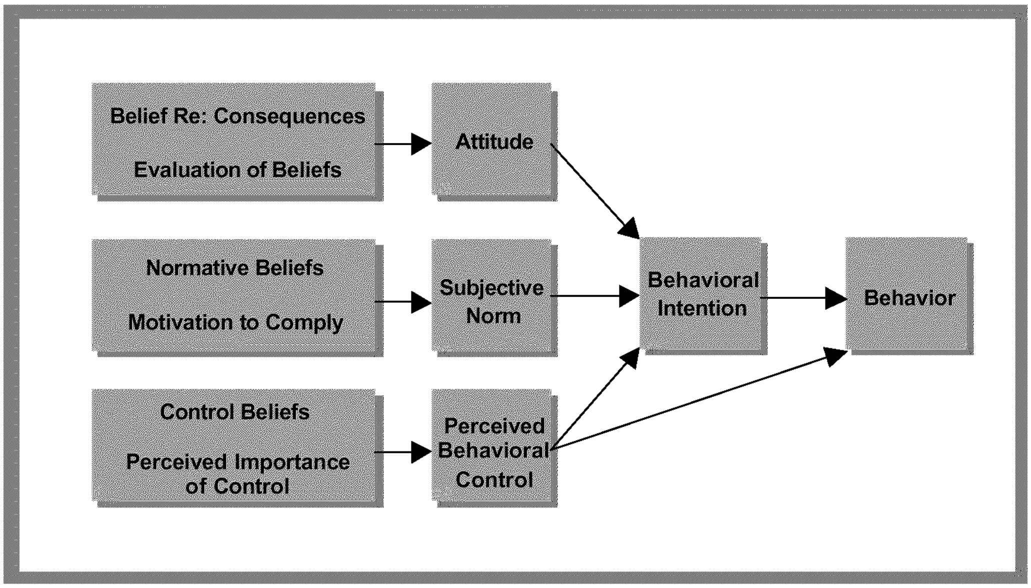

Figure 3-3: Theory of Planned Behavior (2)

3.1.1.4 Evaluation Method Selection

After researching the three models presented here, (TRA, TAM, and TPB), it was determined that the Technology Acceptance Model is the best tool available for predicting future usage of GeoBEST for the following reasons: (a) the TAM was developed specifically for prediction of user acceptance and subsequent use of new information technology, (b) the TAM's foundations are firmly grounded in psychological literature, and (c) the TAM's ability to predict system usage at little cost and minimal difficulty makes it ideal for use in this research effort.

3.2 TAM Implementation

A review of applicable literature did not reveal any specific criteria for using the TAM. The following steps were derived from the previous TAM studies (13) (29) in order to implement the TAM: (a) identify an appropriate study group, (b) develop an evaluation plan, (c) design surveys, (d) test the plan, (e) implement the plan and gather data, (f) analyze the data, and (g) draw conclusions. The following sections discuss how this implementation was carried out.

3.2.1 Identify Study Group

A prospective study group for this research effort must meet the following criteria: (a) the subjects must be prospective future users of GeoBEST, preferably a mix of CE officers and Engineering Assistants, (b) there must be an opportunity for the subjects to use GeoBEST for a realistic beddown planning scenario, and (c) the sample size must be sufficient for statistical analysis. Generally, at least 10 individuals are required per construct in the model (35). To implement the TAM, this requires that the sample be at least 40 individuals.

Several options were considered for prospective study groups, including the Civil Engineer and Services School, the Air Force Institute of Technology graduate education program, base level CE organizations, and Silver Flag. The Civil Engineer and Services School at Wright-Patterson AFB, Ohio conducts an eight-week course entitled Management 101. Its purpose is to provide initial indoctrination training for CE junior officers. A typical class size is 50-60 students, consisting primarily of 2nd Lieutenants, with some 1st Lieutenants and Captains. The students receive training on beddown planning, which culminates with a 1-day beddown planning group exercise. The course presents a sufficient sample size of CE officers, however there is no representation by Engineering Assistants. Also, there is insufficient time for the students to use the software.

The Air Force Institute of Technology, also at Wright-Patterson AFB, Ohio offers a Master's degree in Engineering and Environmental Management (GEEM). Students in this program are primarily Air Force CE junior officers. Occasionally the class will include one or two US Marine Corps engineering officers. When the junior and senior classes are in session, the combined class size is 35-40 students. Again, this meets the sample size criteria, but there is no EA representation. Also, the GEEM program curriculum does not include beddown planning, nor is there time to create and execute a planning scenario sufficient for the goals of this research.

A typical base-level CE squadron contains 7-10 officers and 4-6 EA's. These organizations routinely create beddown plans for field exercises, readiness exercises and inspections, and actual deployments. Meeting the sample size criteria would require coordination with several different organizations at different locations. This assumes that they would be engaged in a beddown planning activity within the time frame for data gathering. These logistical requirements make this option undesirable.

Detachment 1 of the 823rd RED HORSE Squadron at Tyndall AFB, Florida conducts weekly contingency skills training classes for base level CE personnel under the name Silver Flag. Approximately 35 Silver Flag classes are conducted each year for active duty, guard, and reserve units within the continental U.S. A typical Silver Flag class is composed of CE personnel teams from several different units, regardless of their duty status (AD, guard, reserve). These teams arrive at the site on Sunday of their assigned week and their instruction begins the following morning. The students are divided according to their specialty and they receive training on various contingency skills. The students are tasked to develop and execute a beddown plan for a contingency deployment scenario. The plan is presented to the instructors on Wednesday afternoon. The intermediate time (Mon – Wed) is used for classroom instruction during normal training hours and for development of the beddown plan after hours or during specified planning time. On Thursday, the students put this plan into action as they develop a simulated beddown site in accordance with the plan that was briefed and critiqued the day before. A typical Silver Flag class contains approximately ten officers and eight EA's. Using several of these classes would produce a sufficient sample size for this research plan. The time for preparation of the beddown plan is less than three days, which appropriately imitates the real-world time constraints for producing a usable plan. These factors make Silver Flag the most desirable option for a survey group for this research.

Four Silver Flag classes were selected for participation in this research in the fall of 2001. These classes were conducted on the weeks of 16 Sep, 14 Oct, 24 Oct, and 4 Nov. The anticipated final sample size was 65-80 students.

3.2.2 Develop Evaluation Plan

Implementation of the Technology Acceptance Model for this research follows the procedure called prototype testing or system selection. This involves presenting the system under evaluation to a group of prospective users involving about an hour of interacting with the system, which could include a training program and hands-on exercises. After the initial presentation, prospective users are asked to rate, by completing a survey, the future usefulness and ease of use they would expect based on relatively little experience with the system being rated. Managers can use these methods to examine a system for possible future implementation or to decide between two or more competing systems (12:330). The literature provides examples (e.g. 13, 29) of how follow-up surveys, administered after a defined system usage period, could be used to validate the initial TAM results. Though this is not required for TAM implementation, it was attempted for this research to validate the initial results and to solicit qualitative user feedback on system design features after the students had an opportunity to use the system.

The weekly schedule for a typical Silver Flag class is shown in Figure 3-4. It is within this time frame that the TAM was implemented to evaluate GeoBEST.

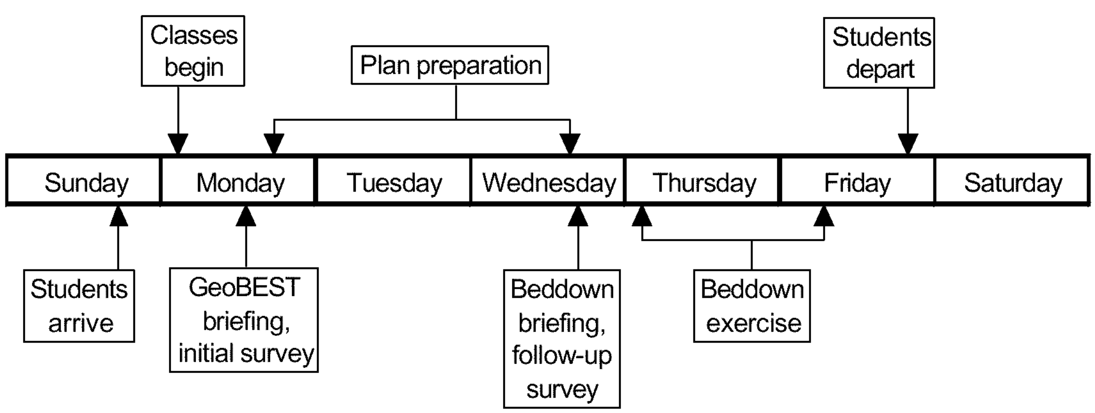

Figure 3-4: Silver Flag Weekly Schedule

Class schedules for the weeks selected were modified to allow for a one-hour presentation of GeoBEST on Monday at noon. To allow the students some hands-on experience with the system during the presentation, arrangements were made for borrowing up to four computers from the base communications support flight for the students to use during the briefing. Students took turns using these computers or they elected to simply observe the demonstration. These computers were available after the presentation for preparing their beddown plan after hours and during scheduled planning time. The students were provided with a handout summarizing the capabilities of GeoBEST as well as a quick-reference sheet showing a screenshot of GeoBEST and callout boxes with descriptions. These handouts can be found in appendices D and E.

The student presentation was designed to maximize the student's exposure to the capabilities of GeoBEST, through demonstration, while at the same time minimizing their exposure to its known flaws. The time allowed for the presentation was one hour, with an additional 10 or 15 minutes if necessary. To ensure that all GeoBEST features were demonstrated, a copy of a training presentation given to the JEFX (see section 1.1) participants was obtained from the GeoBEST contractor. Where possible, each feature was demonstrated, with the exception of those that had apparent flaws that could not be avoided. Because the presentation was intended to be entirely composed of a real-time demonstration, no PowerPoint™ slides were prepared. The following is an outline of the subject areas covered during the lesson:

- GeoBase: description of the GeoBase Initiative and how GeoBEST fits into the GeoReach concept of operations
- Program description: GIS program built on ESRI™ ArcView; database of information found in AF beddown planning publications
- Scenarios: create new or edit existing scenarios; add data files or imagery to scenarios; allocate and manipulate Harvest Falcon/Eagle assets within scenarios; import and export scenarios
- Map generator: create, display, and print pre-formatted maps

- Area analysis: determine number of assets that can fit within a defined geographic space
- 3D viewer: display scenarios in three dimensional format
- Labeling: display various types of labels for description of assets or features
- Constraints analysis: find spacing conflicts between individual assets or groups of assets
- Image registration: merge data file and imagery
- GPS data: import and define Global Positioning System data
- Asset metadata: display and add/delete multimedia asset information
- Report generator: create customized reports based on scenario information
- Scheduler: view generic thirty day calendar of prioritized beddown tasks
- Database management: view and edit the database of beddown and asset information

Following the briefing, the students completed the first of two surveys, which are discussed in detail in section 3.2.3. In order to maximize the potential for productive use of GeoBEST, the researcher was present after hours and during scheduled planning time to provide user assistance if needed. On Wednesday, all students who completed the initial survey completed the follow-up survey to allow for validation of the initial survey results. A separate survey was also administered to cadre instructors after the final class date to gather qualitative feedback on the training presentation and on the program itself.

3.2.3 Design Survey Instruments

Implementing the TAM requires the design of at least the initial survey, and an optional follow-up survey for validation purposes. The initial survey contains a series of questions that measure the TAM variables, *perceived ease of use*, *perceived usefulness*, *attitude towards using*, and *behavioral intentions to use* relative to the IT of interest. Davis developed appropriate survey scales to measure these variables (13:991). These scales were validated and have been adapted for use in this study of GeoBEST.

Evaluation tools, such as the TAM, give researchers the ability to apply scales that have been developed and empirically validated in previous research, thus avoiding potentially time-consuming and costly effort required to develop new measurement instruments (29:61).

Three surveys were designed for this research. They include two student surveys and one cadre survey. The cadre survey was developed to gather qualitative feedback. The cadre consists of the Silver Flag instructors and staff members. The initial student survey consisted of three sections of questions; demographic information; feedback regarding the quality of the training presentation; and, a series of questions that were adapted from previous research to measure the TAM variables. The student follow-up survey asks the students to document how much the students used the system and the TAM questions again to see if their perceptions of the system changed after using the program. Because the cadre members were not active GeoBEST users, they did not answer TAM questions, but instead only answered questions regarding the perceived quality of the system and also any perceived differences in the performance of students who use GeoBEST versus those that elected not to use it.

Because the surveys for this research were administered to personnel units outside of AFIT, approval was required by the Air Force Personnel Center (AFPC) in accordance with Air Force Instruction (AFI) 36-2601. An approval package was prepared and submitted to AFPC on 15 Aug 01 and it was approved on 22 Aug 01. The survey control number is SCN 01-086, and the expiration date is 31 Dec 01. Each of the surveys used in this study can be found in appendix A. Each of the three surveys is described in detail in the following sections.

3.2.3.1 Student Initial Survey

The student initial survey was distributed immediately following the GeoBEST presentation on Monday for each Silver Flag class and collected when they were complete. The survey consists of two main parts, demographics and TAM questions. The first five questions gather demographic information such as rank, duty status, and job title. These questions allow for verification that the students meet the criteria for this study, as described in section 3.2.

Two questions ask for feedback on the quality of the briefing and how well they feel it prepared them to begin using the system. One aspect of TAM implementation that was not found in the literature was a user's evaluation of the quality of the introductory presentation. Responses to these questions will be used to determine whether the perceived quality of the initial user training affected their perceptions of the software's ease of use and usefulness.

The student initial and follow-up surveys each contain twelve questions to measure the four TAM variables based on a 7-point scale known as the Likert scale. An example of this type of question is "The computer program is easy to use," with the seven available responses being "strongly disagree, disagree, slightly disagree, neutral, slightly agree, agree, and strongly agree." Multiple questions are used to measure single variables to allow for variation in how individuals respond to questions with particular word structures. For example, one person may feel that the statements "I am happy" and "I am satisfied" are essentially identical, while another person may perceive that they are slightly, or perhaps greatly different. The process of determining which sets of questions produce the least variance when measuring a particular variable is called Reliability Analysis. Cronbach's Alpha reliability analysis (see section 3.2.5.2) is a statistical procedure used to determine whether or not survey respondents answer questions consistently when those questions measure the same variable. Davis performed this procedure for each of the TAM variables after an initial introduction and after a defined usage period for his study (13). Cronbach's Alpha values range from 0 to 1, where higher values are preferred. An Alpha value of .7 or greater is considered sufficient for social research (8). Davis found that the four item *perceived usefulness* scale achieved a reliability of 0.95 and 0.92 for the initial and follow-up surveys. The four item *perceived ease of use* scale obtained reliability coefficients of 0.91 and 0.90. The four item *attitude towards using* scale obtained reliabilities of 0.85 and 0.82. The two item *behavioral intentions to use* scale obtained reliabilities of 0.84 and 0.90 (13:991). This analysis was repeated on data gathered for this research to ensure consistency.

The Silver Flag students did not supply their names or any other identifying information on the surveys. Therefore it was necessary to have a way of linking their responses on the initial survey to those on the follow-up survey. The last question on each survey asks the students to write in the first two letters of their mother's and father's first name.

3.2.3.2 Student Follow-Up Survey

On Wednesday, the student follow-up survey was administered to all students that completed an initial survey. This purpose of this survey is to gather additional feedback from the students after they had an opportunity to use the software and to validate the

TAM results from the initial survey. The first two questions determined whether or not the individual participated in the beddown planning, and if they did participate, whether they used GeoBEST to help prepare the plan. If so, they continue to the next question. Otherwise, they are directed to skip over the TAM questions, which are only valid if there was actual system usage.

This survey contains three questions designed to measure the fifth TAM variable of *actual system usage*. The first question presents a list of GeoBEST features and asks the student to indicate which features of GeoBEST they used. Two other questions are the second measure of actual usage. The student is asked to indicate how many hours they actually used the system, both personally and as part of a group. The remaining questions request feedback on the student's most liked and most disliked features of GeoBEST. Again, the students are asked for feedback on the quality of the introductory training they received. The final question is open-ended for general comments. Finally, the students are again asked to write in the first two letters of their parent's names to link their responses to the initial survey.

3.2.3.3 Cadre Survey

The cadre survey was given to any cadre member who is either an instructor for the officer or EA classes, or if they viewed at least one of the four GeoBEST presentations. Each participating cadre member completed only one survey. Therefore, if a cadre member was present for all four of the scheduled classes, they completed the survey after the last class in order to maximize their exposure to the system and/or students using the system.

The survey consists of ten questions. The first question asks for their current position at Silver Flag. The second question asks how long they have been working at the site. Questions 3 and 4 asks them to compare the performance of students who used GeoBEST to those that don't, and to elaborate on some of the major perceived differences in the student's performance. The instructors were then asked to provide feedback on the introductory GeoBEST briefings if they viewed any. The remaining questions request feedback on the cadre member's most liked and most disliked GeoBEST features, suggestions for improvement, and any additional comments they may have.

3.2.4 Test the Plan

The purpose of testing the evaluation plan is to help identify any problems in the proposed methodology, to ensure the presentation is adequately timed, and to gather feedback from test subjects on the quality and clarity of the presentation. Ideally, the test case would mirror the conditions expected for the actually evaluation. Due to time and personnel constraints, this was not possible. It was decided to give the GeoBEST presentation to a small number of AFIT students after which they would complete the initial student survey.

This evaluation plan was tested on 27 Aug 01. Approximately thirty AFIT students (about half CE and half Communications officers) were invited to hear a one-hour interactive briefing on GeoBEST after which they would complete a survey. Ten students agreed to participate and six students actually showed up, five CE and one Comm officer. One laptop was used for the GeoBEST presentation and the program was loaded onto three other laptops for the students to use. All of the student laptops experienced different errors that prevented use of GeoBEST, even though two of them were identical to the laptop being used for the presentation, which operated without any apparent problems. Time constraints prevented acquiring other laptops, so a screenshot of GeoBEST in use was displayed on the three laptop screens so the students would have something to reference while viewing the presentation. After the presentation, the student initial surveys were distributed, completed and collected. Most students commented that the process could have been more meaningful had they been able to follow along on their machines. The presentation time was 50 minutes due to other classes needing the room. At least 10 to 15 more minutes were needed to adequately cover all GeoBEST features.

A second trial run was scheduled for the week prior to the first Silver Flag visit using approximately 25 AFIT students from the Graduate Engineering and Environmental Management program. Due to heightened security as a result of the September 11th terrorist attacks, the second trial run was canceled. Very little information was gained from the initial trial run, other than the assurance that the presentation could be adequately covered in the allotted time frame, and that problems should be anticipated when loading GeoBEST on laptop computers.

3.2.5 Overview of Analysis

After data were collected from the four Silver Flag classes, statistical analysis packages SPSS™ and JMP IN™ were used to analyze the results. Following is a brief description of the analysis methods that were used. These are reliability analysis, factor analysis, multiple regression, and analysis of variance.

3.2.5.1 Reliability Analysis

When giving an evaluation survey, the survey instrument should elicit consistent and reliable responses even if questions were replaced with other similar questions. When a variable is measured from a set of questions that return a stable response, then the variable is said to be reliable. Cronbach's Alpha is an index of reliability associated with the variation accounted for by the true score of the construct. A construct is the hypothetical variable that is being measured. For the TAM, USE, EOU, A, and BI are all constructs. Alpha coefficients range in value from 0 to 1 and may be used to describe the reliability of constructs extracted from questions measuring the same construct. The higher the score, the more reliable the generated scale is for measuring the construct of interest. An alpha score of 0.7 or higher is generally regarded as acceptable in psychology-based research (8). Removing questions or adding other questions could improve alpha scores of less than 0.7.

Previous TAM research has indicated that the scales designed to measure the TAM constructs are highly reliable, often with alpha values in excess of 0.8. Reliability analysis was conducted for this research to ensure consistency.

3.2.5.2 Factor Analysis

Factor analysis is a statistical approach that can be used to analyze interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions (called factors). The statistical approach involves finding a way of condensing the information contained in a number of original variables into a smaller set of dimensions (factors) with a minimum loss of information (31).

There are two types of factor analysis, exploratory and confirmatory. For exploratory, the researcher essentially ignores what he or she knows about the factors being measured. Survey data is analyzed as a whole and the procedure extracts factors, indicated by a statistic called an eigenvalue. According to Kaiser's Criterion, eigenvalues greater than one is the criteria for numerically identifying a factor (35). If a survey was designed to measure five factors and only two are identified, then it may be necessary to redesign the scales used to measure the factors. It is also useful to observe how each of the survey questions "load" on the extracted factors. A loading indicates how much variance is explained by a particular question for a specific factor, with values ranging from 0 to 1. When questions load significantly on two or more of the identified factors, this question may need to be removed from the analysis.

In confirmatory factor analysis, the researcher instructs the statistical computer software to extract a specific number of factors. Again, the resulting eigenvalues and loadings gauge the relative strength of the extracted factors. For this research, exploratory factor analysis was used in order to see the number of factors the software was able to extract instead of forcing it to extract a specific number.

3.2.5.3 Regression

In regression, the objective is to build a model that relates a dependent (or response) variable to one or more independent (or predictor) variables (20:573). Modeling using one independent variable is called simple regression while modeling with two or more independent variables is called multiple regression. Figure 3-5 is a graphical representation of simple regression.

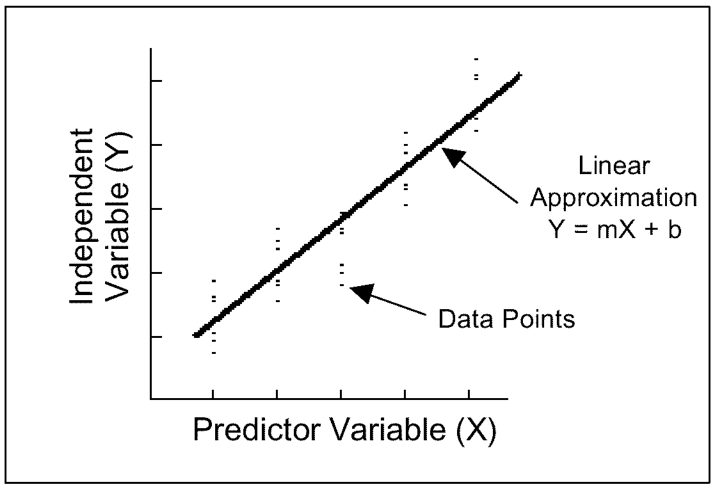

Figure 3-5: Simple Regression

An example of a predictor variable could be average freeway speed for a certain geographic area. The independent variable could be the number of fatal auto accidents at locations where that speed is observed. The data points are plotted on the x-y graph, and through a series of mathematical calculations, a linear approximation is determined for the relationship between speed and number of fatal accidents. This is also known as curve fitting.

Two statistics are primarily used to describe the “quality” of the relationship between the variables. These are the coefficient of determination (R^2) and the regression coefficient (Beta). R^2 values ranges from 0 to 1 and they represent the percentage of variance explained by the variable tested in the hypothesized relationship. In other words, how closely are the data points grouped around the fitted line? For example, within the TAM, an individual’s perceived usefulness of a computer system and their attitude towards using the system are hypothesized to have a positive influence on that individual’s behavioral intention to use the system. This is represented as BI = A + USE. After data is gathered and analyzed, R^2 and Beta values are determined for this relationship to describe its “quality.” An R^2 value of 0.5 would indicate that the TAM explained 50% of the variance in behavioral intentions. Graphically, the data points would appear to follow the line fairly well. An R^2 of 1.0 would indicate that A and USE completely explain the variance in BI. Graphically, all data points would lie directly on the fitted line. A Beta value is determined for each of the independent variables in the equation. This value is the correlation between the independent variable and the dependent variable. Using the previous example, if A had a Beta value of 0.02 and USE had a Beta value of 0.75, then it would be correct to say that USE is highly correlated with BI, whereas A has very little correlation with BI.

For this research, multiple regression is used to examine each of the TAM relationships that ultimately leads to a prediction of the Silver Flag students’ intention to use GeoBEST in the future. Three proposed relationships are examined using regression: (1) perceived usefulness and attitude towards using have a significant positive influence on behavioral intentions to use (BI = USE + A); (2) perceived usefulness and perceived ease of use have a significant positive influence on attitude towards using (A = USE + EOU); and (3) perceived ease of use has a significant positive influence on perceived usefulness (USE = EOU). These three relationships are shown on the TAM diagram in Figure 3-5.

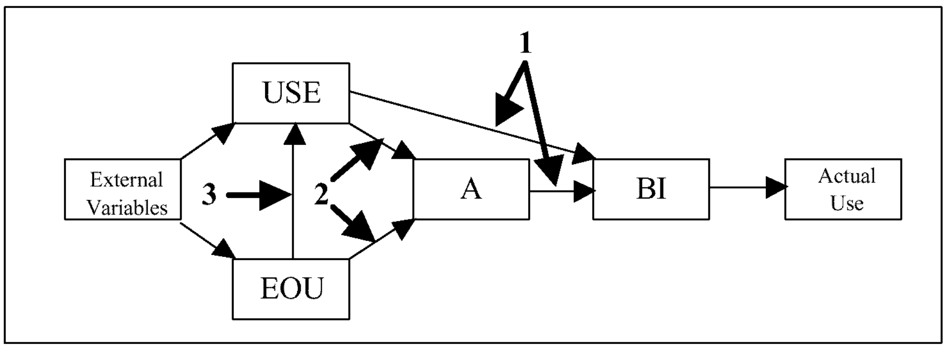

Figure 3-6: TAM Relationships

3.2.5.4 Analysis of Variance

This evaluation of GeoBEST was conducted using individuals from a wide variety of backgrounds and experience levels. For example, although the primary intended audience was CE officers and EA's, the results in Chapter 4 indicate that a significant number of the participants did not meet this criterion, even though their responses were included in the research. It would be useful to know if the responses provided by these other individuals were significantly different from the officers and EA's. The technique used to make this determination is called analysis of variance (ANOVA). ANOVA is used to test the hypothesis that several means are equal. For example, if the average score (on the 7-point Likert scale) for perceived ease of use for the officers and EA's was 5.0, and the average for all others was 4.3, ANOVA indicates whether this 0.7 point difference is significant, and to what degree it is significant. The statistical indicator of significance is the *p* value, which can range from 0 to 1. The difference of means is significant if the *p* value is less than 0.05. Two other levels of increasing significance are *p* values less than 0.01 and 0.001 (35). This research includes several ANOVA tests to determine if students responses to the TAM questions could have been affected by other variables such as their individual attitude towards using computers or their experience with beddown planning. These results give additional insight into the TAM regression results and could also be used to plan for future GeoBEST training programs by indicating which factors affect individual perceptions.

3.3 Limitations and Concerns

Several items were seen as limitations as the plan was prepared for implementation. First, GeoBEST had not been loaded on any of the computers that would be used for the student presentation. Given the unpredictable nature of installing GeoBEST (see sec. 3.2.4), a lack of working computers a major concern. Second, as the researcher was preparing the evaluation plan and learning to use GeoBEST, several system flaws were identified. Some were minor while others seriously impacted the program's advertised capabilities. These flaws are discussed in detail in section 4.2. The majority of GeoBEST's features can be demonstrated without exposure to the serious flaws. Regardless, the result is an incomplete presentation and the students would very likely discover the flaws after minimal system use. Third, the Silver Flag training is very time intensive and students typically find it difficult to complete the beddown plan using current methods in the time allotted. Whether the students would be willing to learn and effectively use a new system, regardless of their perceptions, was a major concern.

3.4 Summary

This chapter has focused on the process used to conduct an evaluation of GeoBEST. Several alternatives were proposed for this evaluation and the Technology Acceptance Model was selected. An appropriate study group was defined and identified. The three surveys to be used were described as well as the statistical methods that will be used to analyze the collected data. Finally, limitations and concerns for this research were identified. The following chapter presents an analysis of the results.

IV. Results and Analysis

4.0 Introduction

The purpose of the analysis chapter is to report the outcome of the procedures outlined in the methodology chapter. Included are the researcher's experiences with GeoBEST in preparation for conducting this study. This chapter also discusses how the Technology Acceptance Model was implemented using the CE students at Silver Flag, including a presentation of demographics, some qualitative feedback on GeoBEST, and statistical analysis of the TAM data.

4.1 Researcher's Evaluation of GeoBEST

A copy of the latest version of GeoBEST (including copies of ESRI™ ArcView and 3D Analyst) was initially obtained from the Air Combat Command Geo Integration Office, Langley AFB, VA (ACC/CEOG), in the Spring of 2001. Soon thereafter, the primary GeoBEST programmer at BTG Delta Research Division of Niceville, FL was contacted to inquire concerning any training for GeoBEST that may have been used in preparation for JEFX 2000. The programmer provided several PowerPoint presentations that were used for initial training of the CE personnel who participated in JEFX 2000. These presentations along with the built-in GeoBEST help files (and trial and error) were used to gain familiarization with the program. After the first few attempts to use GeoBEST, it became apparent that initial familiarity with ArcView would be very helpful. GeoBEST is essentially an add-on program to ArcView. Several problems were encountered while using GeoBEST. These are discussed below along with other features that need attention.

4.1.1 Asset Inventory Tracking

GeoBest is designed to maintain an accurate inventory of all assets in the database. As these assets are allocated within scenarios, GeoBEST tracks the numbers and uses them to make calculations for reports and other analysis. If assets are copied, deleted, or imported from other scenarios, the inventory feature is designed to maintain an accurate count. Frequently this inventory accounting function does not work. The inventory seems to work correctly when dealing with a small number of assets (<10). But as the complexity of operations increases, erroneous numbers begin to appear. This problem is particularly prevalent when copying or deleting groups of assets. It appears the only way to correct this problem is to recreate the scenario and try again, though it is likely the same problem will be encountered. The program is still usable despite this problem, though any calculations or analysis based on the inventory numbers would be useless.

4.1.2 Desktop vs. Laptop

When the GeoBEST program file is executed, ArcView is opened and the program determines the computer's screen resolution, allowing for proper sizing of the ArcView and GeoBEST windows. Throughout the course of this study, GeoBEST was installed on approximately 15 different desktop computers and about the same number of laptop computers. These computers were representative of a wide range of manufacturers and performance specifications. On each of the desktops, GeoBEST didn't seem to have any problem determining the correct window dimensions and sizing requirements. When running on the laptops however, nearly all of them had improperly sized windows, which could be fixed, but was irritating nonetheless. The reader is referred to section 3.2.4, which details the researcher's experience of trying to test the evaluation plan. Three separate laptop computers experienced errors trying to run GeoBEST. Because GeoBEST is designed to be used in the field at forward locations, problems associated with using it on laptop computers should be given higher priority.

4.1.3 Resolution

GeoBEST has apparently been optimized to run at screen resolutions greater than 800 X 600. At this resolution or lower, many of the GeoBEST and ArcView tools are covered by other screen features. Examples of this are shown in Figure 4-1. Arrow #1 indicates the radio buttons for selecting new or existing assets, with the labels covered. Arrow #2 indicates the location for the button needed to scale imagery. The features can be uncovered by stretching the windows left or right, but again this is an irritating inconvenience.

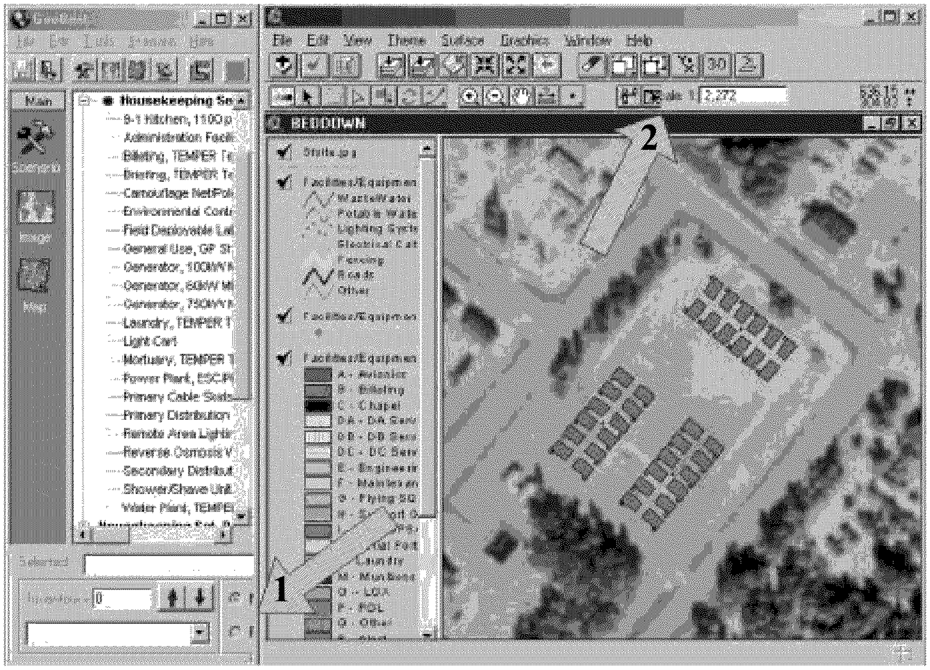

Figure 4-1: Screen Resolution Problems

4.1.4 3D Viewer

The 3D scenario viewer feature is very useful for visualization of the beddown location. However, some problems were occasionally encountered when using it. The first problem, shown in Figure 4-2, involves the background imagery getting “sliced” in half diagonally. The image on the left shows a normal 3D view with the entire image theme and allocated assets (arrow 1) visible. The image on the right is the same view showing the “sliced” theme. Any assets that were placed on the sliced portion of the theme are still visible. This image also shows a black rectangular region on the right side (arrow 2), which sometimes appears when using the 3D viewer. These problems occurred randomly and there is no indication in the help files for how to remedy the situation.

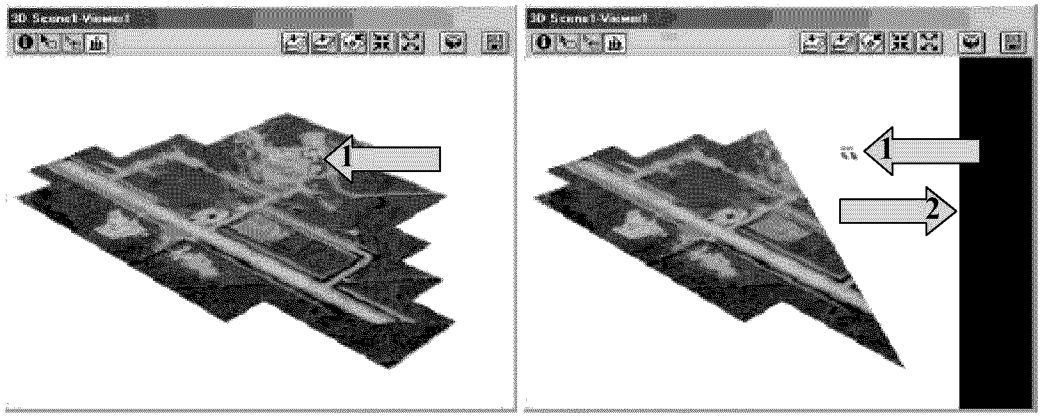

Figure 4-2: 3D Viewer Problems

4.1.5 Online Help Files

The online help files that accompany GeoBEST are a general overview of the program's features with some basic instructions. Interspersed with the text are images of some of the program tools and occasionally some screenshots. The image quality is very poor. This may have been done to minimize file size, but it is often more distracting than helpful. GeoBEST is very dissimilar from the day-to-day software used by the personnel intended to employ the program. Detailed step-by-step instructions for some of the tasks and clear images would be very helpful.

4.1.6 Copying and Pasting Assets

When creating scenarios in GeoBEST, the user has the option of creating a blank scenario (asset inventories set to zero), or use the scenario wizard to determine the appropriate numbers of assets. The primary purpose of the blank scenario option is to create templates, which can then be imported into multiple scenarios. When generating a bare-base layout, the personnel housing area is often composed of multiple rows of identical facilities, such as TEMPER tents. A standard block of these facilities is a perfect candidate for creation of a template. A single set of facilities could be laid out then copied and pasted as many times as necessary. Problems arise when trying to paste multiple assets. First, the pasted objects appear directly on top of the objects that were copied, making it difficult to distinguish between the two. Most users would be familiar with Microsoft Office programs, which paste the objects near the copied objects, but not directly on top of them. Also, when trying to click and drag the pasted objects, there are several seconds of lag time (typically 10 to 15) before the moved objects re-appear in their new location. There is no indication during this time whether the program is busy or if it is stalled. This problem was experienced on computers considered high-end (850 MHz, 128 MB RAM) as well as older machines.

4.1.7 GPS Files

GeoBEST includes the ability to import data files from GPS systems. The data can be added to the scenario in the form of points, lines, or polygons. In order to demonstrate this feature to the Silver Flag classes, sample GPS data files were obtained from BTG. Several attempts were made to import the files into a scenario without success. BTG was contacted but the problem could not be resolved. Therefore this feature was mentioned in the Silver Flag presentations but was not demonstrated. The Silver Flag beddown plan scenarios did not require the use of GPS data.

4.1.8 Map and Report Format

GeoBEST produces preformatted maps and reports, which can be customized to some degree by the user. One map and report feature that cannot be modified is organizational titles and shields. GeoBEST was initially developed for use by units under PACAF. The current version of GeoBEST has PACAF organizational shields and titles on the maps and reports with no option of changing them. BTG has indicated that this capability will be added to future versions (51).

4.1.9 Pre-Built Scenario Templates

The current version of GeoBEST comes with eighteen pre-made scenario templates (minus any background themes) based on the dispersed facility layouts shown in the Bare Base Conceptual Planning Guide, AFPAM 10-219, Vol. 5, Attachment 15 (17). Contemporary beddown planning rarely (if ever) involves using dispersed facility arrangements. The needs of beddown planners would be much better suited by providing non-dispersed arrangements. Throughout the course of this research, the most common problem users had with GeoBEST is the lack of non-dispersed facility templates, particularly personnel housing.

4.1.10 Closing Scenarios

When closing scenarios in GeoBEST, a box appears on the screen giving the user the option of saving the current scenario, closing the scenario without saving, or keeping the scenario open. This feature is not unusual, however, the box appears regardless if the scenario has been changed or not. Most programs only present this option when changes have been made to the object (document, session, spreadsheet, etc.). This is only a minor inconvenience.

4.1.11 Low Inventory Notification

When allocating assets, GeoBEST checks the current asset inventory and compares it to the amount allocated in the scenario. If the allocated amount is greater than or equal to the inventory number for the selected asset, a dialog box appears reminding the user to increase the inventory. The box must be closed before continuing with any operations. Normal use of GeoBEST involves frequently switching between various assets. Having to close this box every time a fully allocated asset is selected is tedious. Also, the box sometimes appeared even when there was inventory available for allocation. The low-inventory notification is necessary, however the best time for it to appear is only when the user attempts to allocate an asset with zero inventory.

4.1.12 Scaling Imagery

GeoBEST includes the ability to scale imagery themes (e.g. Mr. SID, JPEG, BMP, etc.). The user first selects which units to work in (GeoBEST works with feet and meters) and then scales the image based the known dimensions of an object in the image. This could be a building, a runway, or even a single image pixel (if the resolution is known). Scaling is accomplished by first clicking the "Scale Image" button on the ArcView screen. This button only appears if the image theme is selected. After clicking the button, the user defines a rectangle on the image for which the dimensions are known by first selecting one corner, for instance the northwest corner of a building. A dialog box then appears indicating that the first point has been selected. The user then selects the next point to define the rectangle, in this case the southeast corner of the building. A dialog box then appears prompting the user to enter the dimensions of the rectangle. GeoBEST then uses this information to rescale the image. This feature works very well, however when the “Scale Image” button is clicked, there is nothing to indicate what the user should do. A dialog box with basic instructions would be helpful.

4.1.13 Summary of Researcher’s Evaluation

Some of the GeoBEST problems indicated above are minor irritants while others seriously affect the usefulness and ease of use of the program. On 11 Jan 02, the primary GeoBEST programmer was contacted again to see what changes were planned for the next release of GeoBEST, scheduled for the end of January, 2002. Although the basic function and appearance remains the same, several changes have been made to the program. The most significant change is the replacement of ArcView 3.2 with another GIS program from ESRI called ArcGIS. According to the programmer, this change has resulted in dramatic improvement of the GeoBEST functions and elimination or significant improvement of most of the aforementioned problems (51). A copy of the updated version could not be obtained in sufficient time for a more detailed description for this research.

4.2 Results from Silver Flag

Four separate Silver Flag classes were used to implement the TAM for this research. The classes began on 16 Sep 01, 14 Oct 01, 24 Oct 01, and 4 Nov 01. The following sections will discuss pertinent details from each of these classes followed by a presentation of the study group demographics.

4.2.1 16 Sep 01

Due to travel restrictions imposed after the September 11th terrorist attacks, several teams scheduled for Silver Flag this week were forced to cancel their attendance. The class size for the GeoBEST presentation was anticipated to be 15-20 students. This week's class size was 9. Two desktop computers were provided by the Tyndall AFB Communications Squadron. GeoBEST was loaded on these machines and they were prepared for the students to use during the presentation. GeoBEST was also loaded onto the computer used by the cadre for their lessons. The GeoBEST presentation duration was approximately 65 minutes, followed by the students completing the initial survey. Five Silver Flag instructors and the commander were present for the presentation. During the beddown planning periods (Mon night, Tues afternoon and night, and Wed afternoon), the researcher was present to offer assistance to students using GeoBEST. Two students attempted to use GeoBEST, but by Tuesday night, they had not made significant progress and decided to abandon the program in favor of AutoCAD, which all of the EA's and some of the officers were familiar with. The student's beddown plan was briefed on Wednesday afternoon but it did not contain any GeoBEST products (e.g. maps, imagery, reports, etc.). All nine students completed the follow-up survey and the researcher departed the following morning. No cadre surveys were administered during this class. The borrowed computers were disassembled and returned.

4.2.2 14 Oct 01

This week GeoBEST was presented to 18 students. Three desktop computers were provided by base communications squadron. One of the students attempted to use the program. No GeoBEST products were used for the beddown plan. All 18 students completed the follow-up survey and there were no cadre surveys administered.

4.2.3 24 Oct 01

This week's class size was 19 students. The desktop computers used previously were not available, so three laptops were borrowed from the cadre. Unlike previous attempts to use laptops, GeoBEST was fully operational on these machines, despite two of them being significantly older (Windows 95 OS). One of the students attempted to use GeoBEST. Again, no GeoBEST products were used for the beddown plan. All students completed the follow-up survey and no cadre surveys were administered.

4.2.4 4 Nov 01

For the first three classes, no meaningful information was obtained from the follow-up surveys because of the very low usage of GeoBEST by the students. The evaluation plan for the final class was modified, removing the follow-up survey entirely. The presentation and initial survey were given as planned. Three questions that were on the follow-up survey were added to the initial survey. These are "What features of GeoBEST do you like the most?", "What features of GeoBEST do you like the least?", and "What suggestions do you have for future improvement of GeoBEST?"

This week's class size was 25 students. Two of the laptops used in the previous class were used this week. The cadre survey was administered to the four instructors who attended the presentation at least once and to the commander who attended the first presentation. Four of the cadre surveys were returned. The researcher departed following the initial survey. The cadre instructors decided to leave the GeoBEST laptops in place for any students that desired to use them.

4.2.5 7 Nov 01

Following the last Silver Flag class, there was an opportunity to give the GeoBEST presentation to the Management 101 class at the AFIT Civil Engineer and Services School, Wright-Patterson AFB, OH. The class consisted of 45 company-grade CE officers. Due to time constraints and problems with the presentation computer (errors not encountered before), only about 50% of the GeoBEST features normally presented could be shown to this class. The students completed the initial survey, but none of the data were used for this research.

4.3 Silver Flag Demographics

The final Silver Flag sample size was 71 students and 4 cadre members. Half of the students were on active duty, with 20% reserve and 30% Air National Guard. The service branch composition for the students is shown in Figure 4-3, with USAF comprising 90% of the total.

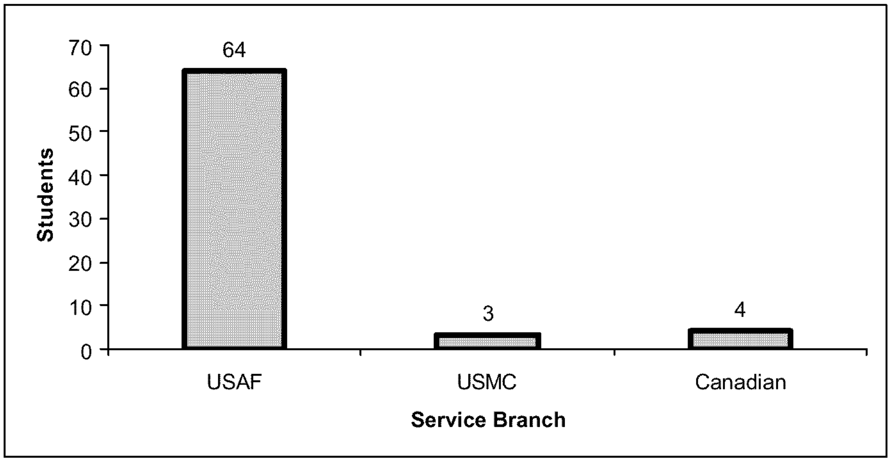

Figure 4-3: Service Branch Composition

The original intent for this research was to focus on the perceptions of base level beddown planners, which is typically Company Grade Officers and NCO's/Airmen. Figures 4-4 and 4-5 show the USAF enlisted and officer rank distribution of the sample.

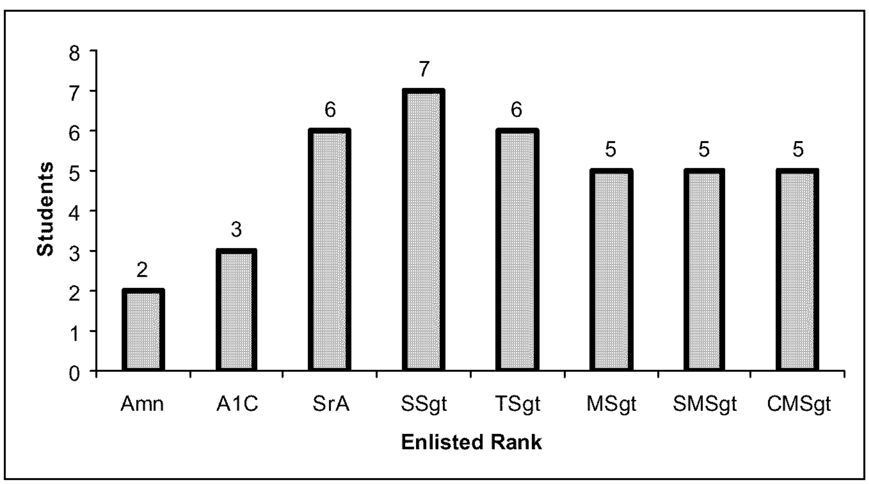

Figure 4-4: Enlisted Rank Distribution (USAF only)

A large percentage of the enlisted sample was composed of Senior NCO's because many of the students were from Guard or Reserve units, which typically have higher ranks than Active Duty units. Also these numbers include enlisted students who are grouped with the officers in the Command and Control classes (e.g. First Sergeant, Fire Chief, etc.), which are typically higher ranking students.

Figure 4-5 shows the Silver Flag AF officer rank distribution. The sample included a higher percentage of Field Grade officers than originally intended. This was largely due to the percentage of Guard and Reserve units attending.

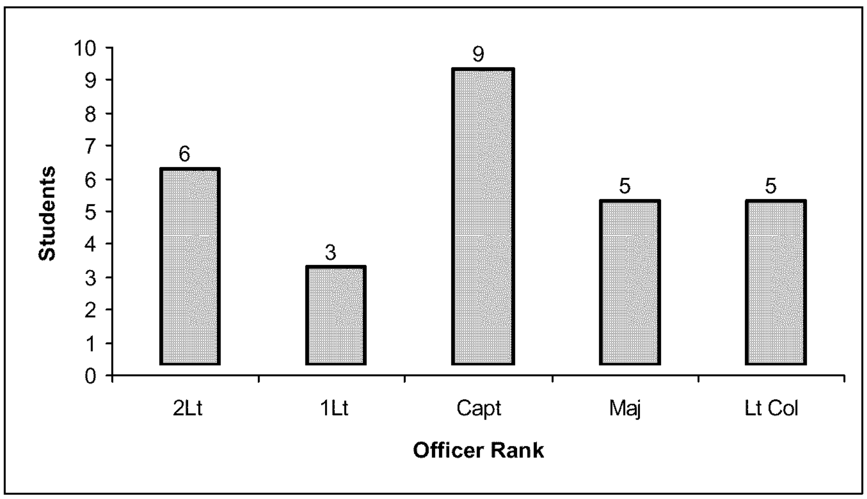

Figure 4-5: Officer Rank Distribution (USAF only)

The primary intended users of GeoBEST are AF CE officers and Engineering Assistants. Figure 4-6 shows that 39% of the 64 USAF students were officers and 33% were EA's. The remaining 28% was composed of 10 enlisted Operations Controllers and 8 others, primarily Senior NCO managers.

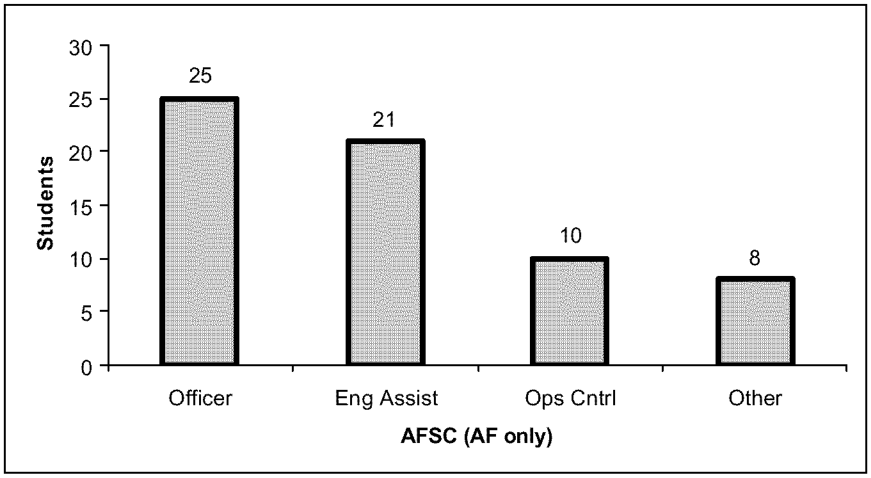

Figure 4-6: Student AFSC

The Silver Flag student demographics do not represent the ideal situation originally desired for this research. First, the rank distributions were significantly heavier in the higher ranks than the desired company-grade officers and NCOs/Airmen. Second, a significant percentage of the students were not either a CE officer or Engineering Assistant. For these differences, it is anticipated that the AFSC difference will have a significant effect on the TAM results. Analysis of variance (section 4.7) will provide these answers. At the very least, it is profitable to get the perspective of seasoned officers and Senior NCO's on new systems and ideas.

4.4 TAM Analysis

The student surveys contained fourteen questions developed and validated by Davis for measurement of the four TAM variables (Table 4-1) (13). The questions are answered on a 7-point Likert-scale, with a score of 7 being the most positive response. Table 4-1 summarizes the twelve TAM questions, sorted by the construct they are designed to measure.

Table 4-1: TAM Construct Items

Construct	#	TAM Statement
Perceived Ease of Use	15	Learning to operate GeoBEST would be easy for me.
	19	I would find it easy to get GeoBEST to do what I want it to do.
	23	It would be easy for me to become skillful at using GeoBEST
	25	I would find GeoBEST easy to use.
Perceived Usefulness	16	Using GeoBEST would improve my performance as a beddown planner.
	20	Using GeoBEST would increase my productivity as a beddown planner.
	24	Using GeoBEST would enhance my effectiveness in beddown planning.
	26	I would find GeoBEST useful for beddown planning.
Attitude Towards Using	13	Using GeoBEST is a (good/bad) idea.
	17	Using GeoBEST is a (wise/foolish) idea.
	21	I (like/dislike) the idea of using GeoBEST.
	22	Using GeoBEST would be (pleasant/unpleasant).
Behavioral Intentions to Use	14	I intend to use GeoBEST for beddown planning.
	18	I intend to use GeoBEST frequently for beddown planning.

Table 4-2 displays the average score for each of the items and then for each construct. The item scores are the average student response to the statements in Table 4-1 on the 7-point Likert Scale. For example, the average student response to item 14, "I intend to use GeoBEST for beddown planning," was 5.09. The possible responses for this item ranged from Strongly Disagree (score = 1) to Strongly Agree (score = 7). The construct score is the average of the item scores for that construct. For example, the construct "Perceived Usefulness" had item scores of 5.90, 5.55, 5.80, and 6.00, which average to 5.81.

Scores higher than 1.00 and lower than 4.00 are considered negative responses, scores higher than 4.00 but less than 5.00 are considered neutral, and scores higher than 5.00 are considered positive. EOU, USE and A all scored well within the positive region, while BI scored technically neutral, but was very close to the positive region. Reliability analysis will determine the consistency of the student responses. Exploratory Factor Analysis will examine the data for factors, or constructs, as a means of verifying the structure of the TAM. Multiple Regression will be done to examine the quality of the variable inter-relationships. Analysis of variance will then be conducted to see if these score were influenced by certain external variables such as AFSC and perception of the training program quality.

Table 4-2: TAM Item and Construct Scores

Construct	#	Item Score	Construct Score
Perceived Ease of Use	15	5.39	**5.32**
	19	5.03	
	23	5.51	
	25	5.35	
Perceived Usefulness	16	5.90	**5.81**
	20	5.55	
	24	5.80	
	26	6.00	
Attitude Towards Using	13	6.39	**6.03**
	17	6.15	
	21	6.15	
	22	5.44	
Behavioral Intentions to Use	14	5.09	**4.97**
	18	4.84	

4.4.1 Reliability Analysis

Reliability analysis (see section 3.2.5.1) was performed on the TAM data as a check for internal consistency. The results of this analysis are shown in Table 4-3. Each construct received a score greater than 0.85, which is well above the minimum of 0.7 recommended for psychology-based research (8). It is concluded that the questions shown in Table 4-1 are internally consistent, and therefore reliable.

Table 4-3: Reliability Analysis

Construct	Cronbach's Alpha
Perceived Ease of Use (EOU)	0.92
Perceived Usefulness (USE)	0.89
Attitude Towards Using (A)	0.86
Behavioral Intentions to Use (BI)	0.87

4.4.2 Factor Analysis

The next portion of the analysis was done using exploratory factor analysis in SPSS (see section 3.2.5.2). The twelve items for perceived ease of use (EOU), perceived usefulness (USE), and attitude towards using (A) were analyzed. Items measuring behavioral intention (BI) were not included because it is the dependent variable in the TAM and including it in this analysis would not yield useful information because it is highly correlated with each of the other constructs. Ideally, factor analysis would identify three distinct factors having eigenvalues greater than one with strong loadings (greater than 0.4) on their respective constructs. The results of this analysis are shown in Table 4-4.

Two factors were extracted with eigenvalues greater than 1, meeting the Kaiser Criterion (35). The EOU items all loaded on the second factor, while all but one of the USE and A items loaded significantly on the first factor. Item 22, "Using GeoBEST would be (pleasant/unpleasant)," was found to cross load on both factors, which was also observed in the literature (29:62). It is noted that the USE item loadings range from 0.435 to 0.762, while the A item loadings (excluding 22) ranged from 0.933 to 0.96, indicating a significant grouping with the construct A within the extracted factor.

Table 4-4: Factor Analysis Results

Construct	Item #	Factor 1 Eigenvalue = 7.15	Factor 2 Eigenvalue = 1.88
Perceived Ease of Use	15	-0.15	0.96
	19	0.11	0.82
	23	0.00	0.88
	25	0.00	0.94
Perceived Usefulness	16	0.71	0.23
	20	0.62	0.32
	24	0.44	0.54
	26	0.76	0.17
Attitude Towards Using	13	0.93	-0.12
	17	0.94	0.00
	21	0.96	0.00
	22	0.31	0.55

Extraction method: Principal Component Analysis
Rotation method: Oblimin with Kaiser Normalization (8 interations)

The purpose of this research was to implement the TAM as opposed to analyzing the model for improvement. Therefore, even though this analysis could not clearly distinguish between USE and A, this study will continue to make a distinction and treat them as two separate constructs. The results of this factor analysis are not ideal, however they are not skewed to the point that one would question the validity of the model either. The way the items loaded against one factor or the other could be due to the small sample size.

4.4.3 Regression

Multiple regression (see section 3.2.5.3) was used to examine relationships within TAM. The three hypothesized relationships from the model are (1) BI = A + USE, (2) A = USE + EOU, and (3) USE = EOU. Table 4-5 displays the regression results and is followed by a discussion of each relationship.

Table 4-5: Multiple Regression Results

						R^2	Beta
1.	BI	=	A	+	USE	0.39	
			A				0.29
					USE		0.38
2.	A	=	USE	+	EOU	0.61	
			USE				0.77
					EOU		0.03
3.	USE	=	EOU			0.44	
			EOU				0.67

4.4.3.1 Behavioral Intention

TAM explained a very significant proportion of the variance in BI ($R^2 = 0.39$). In other words, a manager faced with the decision of whether or not to implement this software could look at the score for BI (from Table 4-2 = 4.97) and be very comfortable in saying this number reflects the true intentions of the test subjects. USE had a strong effect (Beta = 0.38) while A had a slightly smaller effect (Beta = 0.29). With a score of 4.97 (rounded to 5.0 = "slightly agree" on the Likert scale) these results support a strong prediction of marginal usage of GeoBEST by the Silver Flag students. Analysis of variance is conducted to check for external variable effects (section 4.5.4).

4.4.3.2 Attitude Towards Using

Regression analysis of A and USE is done to examine the internal workings of the TAM. TAM explained a large proportion of the variance in A ($R^2 = 0.61$). It is interesting to note that USE was found to be highly correlated with A (Beta = 0.77) while EOU had an insignificant relationship (Beta = 0.03). This observation was also made by Davis, Bagozzi, and Warshaw in their comparison of TRA and TAM (USE Beta = 0.61, EOU Beta = 0.02) (13:992).

4.4.3.3 Perceived Usefulness

When examining the relationship between USE and EOU, a very significant difference was found between the results found in this research and those found in the literature. Davis, Bagozzi, and Warshaw found that the TAM explained only 1% of the variance in USE (Beta = 0.10) (13:992), and Morris and Dillon found that the TAM explained only 4.7% of the variance (Beta = 0.098) (29:63). This research found a much stronger relationship between USE and EOU, with the TAM explaining 42% of the variance in USE (Beta = 0.65). The cause of this difference in unknown.

4.4.3.4 Actual Usage

The original intention for this research was to validate the TAM results from the initial surveys by administering a follow-up survey after the beddown planning period to again measure the TAM variables and to measure actual system usage. This was not possible because so few students actually tried to use the system. This does not invalidate the initial TAM results, although much information could be gained from TAM results following actual usage of the system.

4.4.4 Analysis of Variance

Several questions in the student surveys were intended to elicit responses that could be used to determine whether their perceptions of GeoBEST could be related to other variables external to the TAM. These include the following: (1) Air Force Specialty Code, (2) attitude towards using computers, (3) past or current beddown planning frequency, (4) perceived personal beddown planning skill, (5) qualitative assessment of the introductory training, and (6) level of preparedness to begin using GeoBEST. The student's responses to the TAM questions are examined to see if there is a significant difference between student perceptions of GeoBEST when grouped by these external variables.

4.4.4.1 Air Force Specialty Code

The primary intended audience for this research was base level CE officers (32E) and EA's (3E5). However, 28% of the sample did not meet this criterion. These were enlisted CE operations controllers (3E6) and various senior enlisted CE managers (Operations Superintendent, First Sergeant, Fire Chief, etc.). Table 4-6 shows the analysis of variance for students grouped by Officer/EA, and other AFSC's.

Table 4-6: AFSC Significant Differences

Construct	Officer/EA N = 46	Other N = 18	Difference	Significance
EOU	5.93	5.43	0.50	0.0329*
USE	5.42	4.82	0.60	0.0498*
A	6.02	6.00	0.02	0.9112
BI	5.21	4.28	0.93	0.0170*

Note: * $p < .05$
** $p < .01$
*** $p < .001$

The numbers in the Officer/EA and Other columns are the average TAM scores for that AFSC criterion and the respective TAM variable. The Difference column is the difference between the low and high scores. The Significance column shows the *p* value for each comparison of average scores. The difference between responses for the TAM variables EOU, USE, and BI are shown to be significant at the 0.05 level. The very small difference for the A variable is likely because a person's attitude towards using a system is not directly linked the probability of their using the system in the future. For example, a Fire Chief may never have an opportunity to use GeoBEST, but he or she would likely have a similar opinion of its value. The most significant result from this analysis is the increase in BI from 4.97 to 5.21 when only looking at officers/EA's. The prediction of marginal future usage now has added strength.

4.4.4.2 Attitude Towards Computers

The student initial survey contained two seven point Likert-scale questions designed to gauge their attitude towards using computers, "I enjoy using computers," and "I find a computer easy to use," with possible responses ranging from Strongly Disagree to Strongly Agree. Table 4-7 summarizes the number of student responses to these questions.

Table 4-7: Student's attitude towards computers.

Response	"I enjoy using computers."	"I find a computer easy to use."
Strongly Agree	25	21
Agree	37	37
Slightly Agree	5	9
Neutral	4	2
Slightly Disagree	1	2
Disagree	0	0
Strongly Disagree	0	0

The responses were examined to identify two or more distinct grouping of responses for comparison. The responses could be divided into three groups, high (st. agree, agree, and sl. agree), neutral (neutral), and low (sl. disagree, disagree, and st. disagree). As a rule of thumb, this type of analysis requires at least five responses in each group. As seen in Table 4-7, both of the lowest categories on both questions received zero responses, making it impossible to meet the size requirement. Therefore, it is concluded that the entire student sample has similar attitudes towards using computers, with variance being insignificant.

4.4.4.3 Beddown Planning Frequency

The next area for analysis is the frequency with which the students are required to produce or contribute to portions of a beddown plan. The students were asked, "In general, how often are you required to produce beddown plans (or contribute to portions of a plan)," with responses Never, Rarely, Occasionally, and Frequently. In retrospect, the researcher believes that defining the categories (e.g. Rarely = 1 plan/3 years) would have made for a more meaningful analysis. Figure 4-7 summarizes the responses to this question.

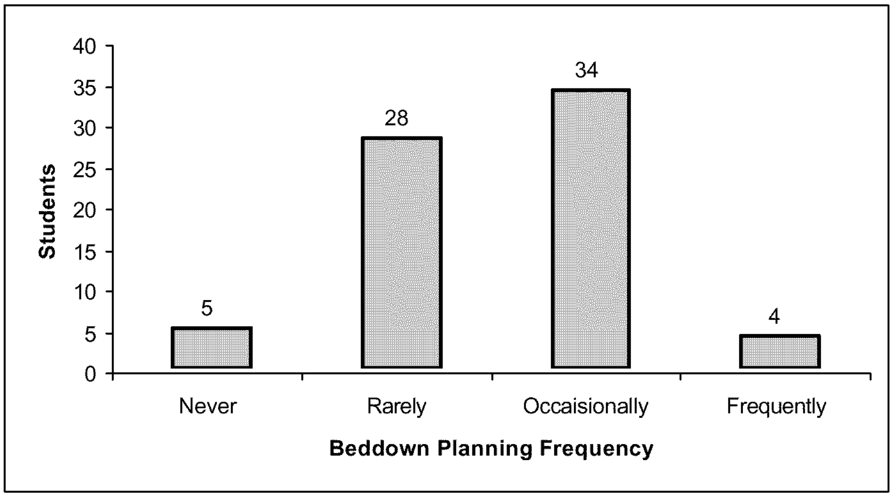

Figure 4-7: Perceived Beddown Planning Frequency

The responses are divided into two broad frequency categories, Low (Never and Rarely) and High (Occasionally and Frequently). The results are shown in Table 4-8.

Table 4-8: Beddown Planning Frequency Significant Differences

Construct	Low N = 31	High N = 33	Difference	Significance
EOU	5.15	5.36	-0.21	0.4528
USE	5.72	5.86	-0.14	0.5180
A	6.09	5.95	0.14	0.4177
BI	4.79	5.09	-0.3	0.3999

Note: * $p < .05$
** $p < .01$
*** $p < .001$

Each of the significance levels in Table 4-6 is greater than 0.05. Therefore, an individual's beddown planning frequency does not have a significant effect on their perceptions of GeoBEST, relative to the TAM constructs.

4.4.4.4 Beddown Planning Skill

To measure a students perceived personal beddown planning skill level, they were asked "How would you describe your personal level of beddown planning ability," with responses No ability, Novice, Intermediate, and Expert. Figure 4-8 summarizes responses to this question.

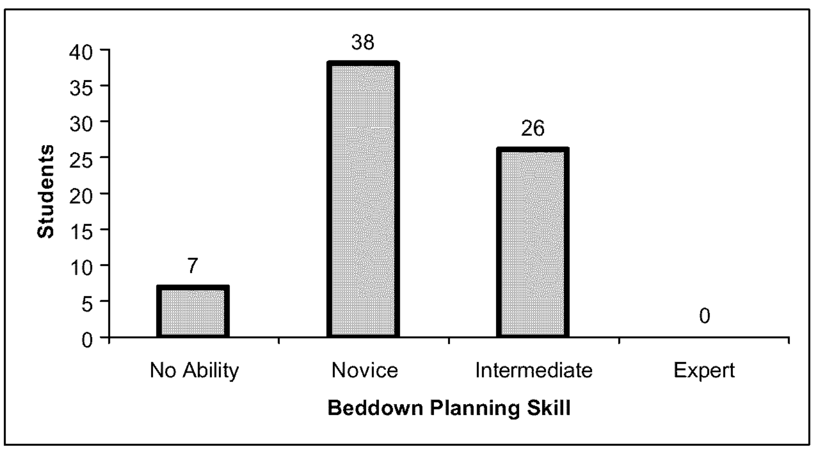

Figure 4-8: Perceived Personal Beddown Planning Skill

Again, the responses are divided into two broad skill categories, Low (No Ability and Novice) and High (Intermediate and Expert). The results are shown in Table 4-9.

Table 4-9: Beddown Planning Skill Significant Differences

Construct	Low N = 45	High N = 26	Difference	Significance
EOU	5.23	5.47	-0.24	0.3817
USE	5.74	5.93	-0.19	0.3603
A	6.07	5.96	0.11	0.5183
BI	4.78	5.31	-0.53	0.1221

Note: * $p < .05$
** $p < .01$
*** $p < .001$

As indicated by the significance levels in Table 4-9, an individual's perceived personal beddown planning skill does not have a significant effect on their perceptions of GeoBEST.

4.4.4.5 Introductory Training Quality

A review of the available literature regarding information system acceptance reveals little concerning the quality of the training given to the prospective users, on which their perceptions are partially based. This is especially significant considering the TAM is designed to be a parsimonious tool for managers, requiring only a short (one hour) introductory presentation and questionnaires (13:1000). Torkzadeh and Dwyer suggest, on the basis of their data, that user training influences acceptance by affecting satisfaction and user confidence (39). Their study, however, was conducted outside of the TAM, TRA, and TPB frameworks (21:14). It is hypothesized here that the user's perceived quality of the training program used to implement the TAM has a significant effect on that user's responses to the TAM variables.

The Silver Flag students were asked two questions on the initial survey to gauge their perceptions of the introductory GeoBEST presentation. The first was "How would you describe the introductory training you just received on GeoBEST?”, with responses Useless, Insufficient, Adequate, Useful, and Very Useful. Figure 4-9 shows the student’s responses to this question.

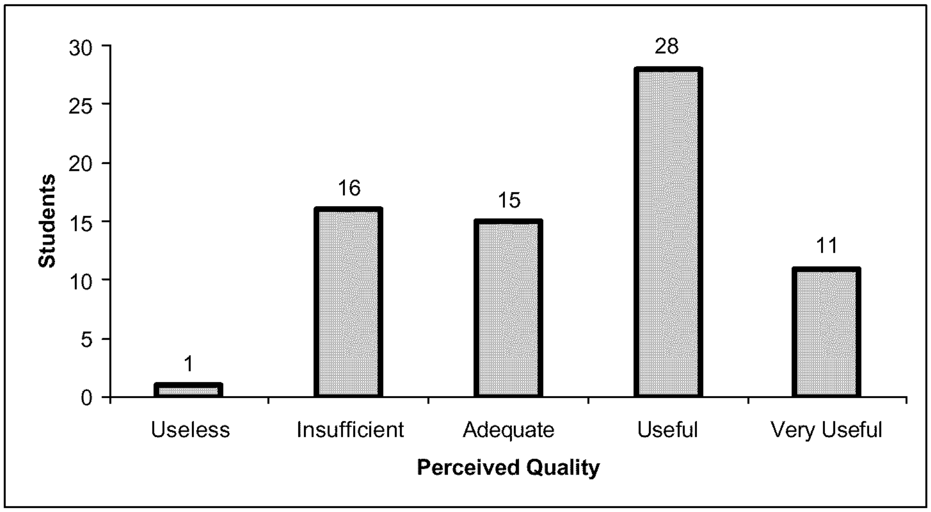

Figure 4-9: Perceived Quality of GeoBEST Training

Analysis was done to determine whether a student’s qualitative perception of the GeoBEST training program affected how they perceive the software itself. The responses in Figure 4-9 are arranged in three quality groups, Poor (Useless and Insufficient), Adequate (Adequate), and High (Useful and Very Useful). Oneway ANOVA results are shown in Table 4-10.

Table 4-10: Training Quality Significant Differences

Construct	Poor N = 17	Adequate N = 15	High N = 39	Difference	Significance
EOU	5.00	5.40		-0.40	0.2515
	5.00		5.43	-0.43	0.1889
		5.40	5.43	-0.03	0.9330
USE	5.49	5.83		-0.34	0.2385
	5.49		5.95	-0.46	0.0526
		5.83	5.95	-0.12	0.6505
A	5.69	5.95		-0.26	0.3476
	5.69		6.21	-0.52	0.0087**
		5.95	6.21	-0.26	0.1587
BI	4.21	5.07		-0.86	0.1078
	4.21		5.27	-1.06	0.0071**
		5.07	5.27	-0.20	0.6061

Note: * p < .05
** p < .01
*** p < .001

The ANOVA results in indicate very significant differences for Attitude Towards Using (A) between the Poor and High groups (p = 0.0087) and for Behavioral Intention to Use (BI) between the Poor and High groups (p = 0.0071). These results support the hypothesized relationship between perceived training quality and TAM responses. However, it is inappropriate to conclude that training quality is the only factor affecting the user's perceptions.

The second question used to gauge qualitative perception of the training program is "How would describe you personal level of preparedness to begin using GeoBEST?", with six available responses ranging from Very Unprepared to Very Prepared. The student responses are summarized in Figure 4-10.

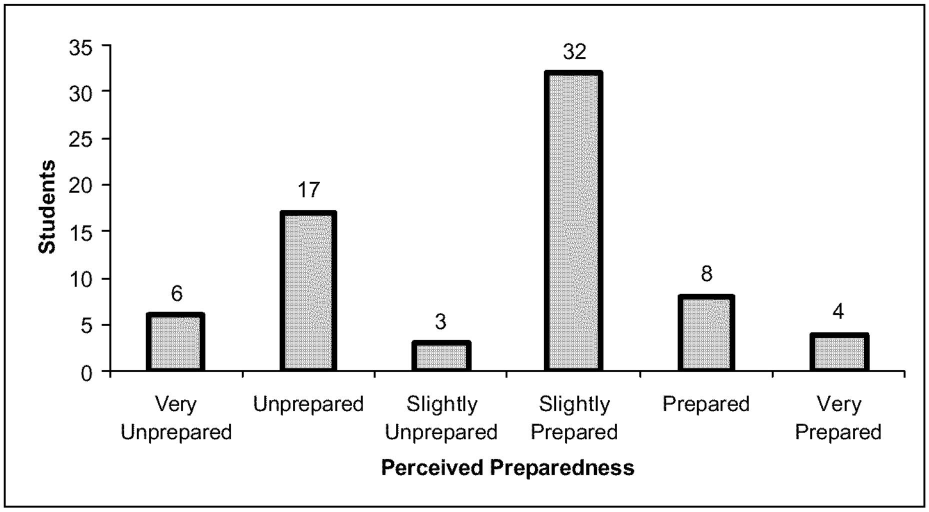

Figure 4-10: Student Preparedness to Use GeoBEST

Analysis was done to determine whether a student's perceived preparedness to begin using the software could affect how they perceive the software itself, with regard to the TAM variables. The responses in Figure 4-10 are arranged in three preparedness groups, Low (Very Unprepared and Unprepared), Medium (Slightly Unprepared and Slightly Prepared), and High (Prepared and Very Prepared). ANOVA results are shown in Table 4-11.

Table 4-11: Preparedness Significant Differences

Construct	Low N = 23	Med N = 35	High N = 12	Difference	Significance
EOU	4.51	5.54		-1.03	0.0002***
	4.51		6.19	-1.68	0.0001***
		5.54	6.19	-0.65	0.0161*
USE	5.3	5.93		-0.63	0.004**
	5.3		6.49	-1.19	0.0003***
		5.93	6.49	-0.56	0.0175*
A	5.83	5.98		-0.15	0.4133
	5.83		6.58	-0.75	0.0044**
		5.98	6.58	-0.60	0.0026**
BI	3.87	5.23		-1.36	<.0001***
	3.87		6.33	-2.46	<.0001***
		5.23	6.33	-1.10	0.0024**

Note: * p < .05
** p < .01
*** p < .001

Preparedness means comparison shows by far the most significant results. All but one of the tested differences is at least significant at the 0.05 level, with five of the twelve being significant at the 0.001 level. The reasons for this are unknown. It is sufficient to conclude in this research that user's who do not feel confident in their ability to begin using a system will have significantly lower intentions to use the system in the future.

4.5 Qualitative Feedback

The Silver Flag surveys contained several questions requesting qualitative feedback on the training program and on GeoBEST. Following are a sampling of the responses to these questions. A complete list of responses can be found in Appendices B and C. Responses from the students are followed by cadre responses.

4.5.1 "Do you have any recommendations for improving the training?"

STUDENT

- Allow a longer block of time. One hour was not enough.
- If it is to be used Air Force wide, more than one hour of training is needed.
- Deploy to Air National Guard sites for use/feedback. Demonstrate where the database data is located within the Technical Orders. Prove to the audience that the numbers are accurate.
- Increase the time to four hours minimum.
- Good presentation. Individual access to the program for each candidate would be nice.
- Formalize into required training.
- I believe that a background in GIS would be necessary to fully appreciate this software.
- Could have a representative from the contractor present for questions.

CADRE

- GeoBEST is very similar to AutoCAD and there's just not enough time for the student hands-on required to learn the system. Recommend this be primarily a home station training requirement, but that we include GeoBEST orientation at Silver Flag.

- Familiarization training is good for "gee whiz" info…I can imagine that training held for actual usage of software would be quite entailed.
- Need more in-depth training and practice time for students.
- Really, the only thing I would change would be switching the "fly-by"command to an "undo" command. Fly-by is a nice visual to have, but undo would get a lot more use.

4.5.2 "What features of GeoBEST do you like the most?"

STUDENT

- 3D and programming. With 3D you can see it in a cool way. Programming is good for those who start OJT. It has everything you need to know for starters there.
- The ability to put down the number of aircraft you need to support and the program producing all the assets needed for the deployment.
- The siting and rotational capability. I like the overall capability of GeoBEST because it has a lot of range on layouts and scenarios. Less complicated to work with than AutoCAD.
- Not familiar with program. Only saw the introduction to it. Seems like an excellent tool though.
- The intelligence and user friendly controls of the program. The program works with you tracking your design and assisting in correct beddown planning procedures.
- Without actually trying GeoBEST I find it hard to provide an accurate description of what I would use it for and how easy it would be to use.

CADRE

- It is a very USEFUL tool - once you know how to use it. It makes beddown planning faster/easier.
- Tracking of assets and ensuring proper distances between facilities/groups.
- Automatic tracking of placed assets.
- 3D is always nice when presenting presentation to be briefed.

4.5.3 "What features of GeoBEST do you like the least?"

STUDENT

- Due to being unfamiliar with GeoBEST it was more time consuming than the traditional methods for the exercise.
- Functions. Unlike AutoCAD, you can't type in what you want to do. You have to drag/click. That takes up too much time.
- Requirements of putting drawings to scale in feet or meters. Using AutoCAD drawings in different units would allow for use during this exercise. Would not correct siting mistakes [referring to constraints analysis].

- 3D fly-by feature is one-speed, making this feature useless.
- Not able to generate any limfacs/shortages.
- It seems like it would take a lot of training to get efficient with the program.
- One would need to master ArcView to properly use this program.

CADRE

- The menus and icons are difficult to navigate because they're not "standard" (like other operating systems). It takes too many "clicks" to open a file to work in.
- No preset facility groups (such as 24-tent non-dispersed layout)

4.5.4 “What suggestions do you have for future improvements of GeoBEST?”

STUDENT

- When copying an object, allow the user to paste the object where they would like to, not on top of the old one.
- Adapt it to the different services.
- Add aircraft templates and dimensions (wingspan, height, etc.).
- Hope to get full-blown training before this gets implemented.
- Make it much more user-friendly prior to fielding. Also make sure that Harvest asset packages are not modified/obsolete prior to fielding this software.
- Be able to integrate with AutoCAD more easily and effectively.
- After notifying you of spacing conflicts, it should automatically resolve the problem, or ask you if you want to solve them.
- I would like to see some capabilities expanded. Ease of conversion of units, importing AutoCAD and Microstation smart maps and any associated information.

CADRE

- Move more towards point-and-click options instead of all the pull down menu options.
- PLEASE give me an "undo" button.
- Need groups of structures in non-dispersed layout.
- Have a command of an option that will let you place entire Temper Tent and Alaskan Small Shelter block (I don't recall there being one.)

4.5.5 “Do you have any additional comments?”

STUDENT

- Extremely useful program for more than just beddown planning. It would take some time, but I would learn to use this program.

- Will be very useful when some of the glitches are worked out.
- The lesson was good for the amount of time slated.
- Send a trial copy to EA's at the bases. They are the ones that will be using it the most.
- If we (the base level engineers) are to use this program, then an all-inclusive software package should be sent.
- Based on the short intro I think it will be an excellent tool, as long as adequate training is available along with the software. It's difficult to say how easy it will be to learn based on such a short intro.
- Capt Jensen was a great teacher for such a short time period. Thanks!

CADRE
- I think this system will prove very useful once it's implemented. Officers/EA's in the field just need a good solid week of training on it before they can use it effectively.
- Great beddown tool once all units get incorporated.
- The entire class was great! Capt Jensen did an outstanding job!

After examining the student and cadre responses, several themes became evident. These are summarized below:

- The one-hour introductory training was insufficient if the students were expected to use GeoBEST for their beddown plan.
- Not only does the training need to be much longer, there needs to be more opportunity for hands-on experience, with a separate computer for each student.
- GeoBEST contains many tools that have more gee-whiz potential than actual usefulness.
- GeoBEST is an assortment of possibly useful tools, provided that the program errors are corrected and the users are provided with adequate training.
- The conditions for using GeoBEST at Silver Flag made other planning options more appealing and feasible (eg. "stubby-pencil," AutoCAD, etc.).

4.6 Summary

GeoBEST was thoroughly explored prior to presentation at Silver Flag and was found to have some serious internal problems. The student presentation was modified in order to avoid these known problems, which likely skewed the results in favor of GeoBEST. Installing GeoBEST on various computers was often problematic. Errors were encountered that prevented any kind of use of the program, even after reinstalling. The TAM was implemented and the result was a strong prediction of slightly likely future usage of the tested version of GeoBEST by CE officers and Engineering Assistants. However, these results are very likely inaccurate because the students did not have much time to actually use the program, during which they would have encountered the known problems. The qualitative feedback indicates that the students and cadre value the tools and capabilities provided by GeoBEST, but they also have many problems they would like to see resolved first. The current version of GeoBEST is broken, but it does provide a good view of capabilities that CE beddown planners will hopefully see in future versions of the software. The implications of these and other findings will be discussed in greater detail in the following chapter.

V. Conclusions

5.0 Introduction

The purpose of the conclusions chapter is to summarize the research, to examine the implications of significant findings, to address the research limitations, and to identify opportunities for future research. The TAM results are summarized as well as some implications for future use of the TAM. Also discussed are implications for future implementation of GeoBEST.

5.1 Summary of Research

Base level Civil Engineering officers and Engineering Assistants have responsibilities in development of contingency beddown plans that could be assisted by products that include geographic information technology, such as GeoBEST. Prior to its implementation Air Force-wide, GeoBEST needs to be thoroughly evaluated under realistic beddown planning conditions, using subjects that are prospective future users of the program.

These conditions were met through implementation of the Technology Acceptance Model at the Silver Flag contingency skills training site. Seventy-one CE personnel were given a one-hour interactive presentation of GeoBEST and were then given a survey to measure their perceptions of the software using the TAM and qualitative feedback. These results were analyzed and the TAM provides a strong prediction of marginal future usage of GeoBEST by officers and EA's. This result is especially significant considering the fact that the majority of the students did not actually use the program, and their perceptions were based solely on the initial presentation. It is anticipated that the TAM would have predicted a much lower likelihood of future usage had more students been exposed to the program's flaws.

This research attempted to validate the prediction made by the TAM data from the initial survey by defining a system usage period and administering a follow-up survey. This attempt failed for primarily one reason—task saturation. Producing a detailed beddown plan is an intensive, laborious, time-consuming process. The Silver Flag schedule requires this to be done within a couple of days, minus classroom instruction time. A more realistic usage period for evaluation of GeoBEST would be on the order of a year, after the students have had an opportunity to use GeoBEST for multiple plans such as base exercises and/or real-world deployments. Nevertheless, the failure of the validation attempt does not invalidate the initial TAM results, which are based entirely on initial perceptions and the brief introduction to the system. However, much more realistic data could have been gathered if the student's perceptions would have been based on their own use instead of someone showing them what the program can do.

Analysis of variance tests were conducted to determine whether certain variables external to the TAM had any significant effects on the user's responses to the TAM questions. It was found that individuals who were not CE officers or EA's had significantly different responses to the TAM questions. This result is predictable. The students who were not officers or EA's would not likely have opportunity nor reason to use GeoBEST in the future, therefore their perceptions of the program should be somewhat different. Also, it was found that the perceived quality of the introductory presentation had a significant effect on the TAM results while perceived preparedness to begin using GeoBEST following the presentation had a very significant effect. These results are in agreement with the qualitative feedback provided by the students and cadre which focus heavily on the need for longer and more hands-on training before student's could be expected to make productive use of GeoBEST.

The Joint Expeditionary Forces Experiment (JEFX) (see section 1.1) provided a thorough analysis of GeoBEST under realistic usage conditions, although the analysis was not complete due to the limited number of users, the lack of participation by base-level planners, and the absence of acceptance theory testing. This research effort addressed these limitations and the results act as a compliment to the JEFX results in providing the necessary rigorous evaluation of GeoBEST.

5.1.2 Implications for GeoBEST Implementation

Several problems were encountered while using GeoBEST (see section 4.2). Some of these were simply irritants while others were outright defects (bugs). Every effort was made to avoid these bugs during the demonstrations, though some were occasionally seen. This resulted in a limited presentation of the program, and for some features, a failed presentation. Also, on several occasions, GeoBEST experienced errors that caused the program to crash, and in some instances, prevented any use of the program at all. This problem was particularly prevalent on laptop computers. The cause of these errors and the other identified system flaws must be corrected if future users are to have any confidence in the software.

A large percentage of the qualitative responses to this research mentioned the need for more time and more hands-on training. Many of the students commented that the GeoBEST presentation was a good introduction to the program, but they did not consider it to be "training." Silver Flag sites at Tyndall AFB and overseas, as well as the Air Force Academy, are in the process of developing a curriculum for GeoBEST instruction. These sites would do well to allow at least one to two days minimum for interactive lessons and hands-on experience with the system. Some of the Silver Flag cadre members envision Silver Flag serving as introductory and refresher GeoBEST training with primary training taking place at home station.

5.1.3 Implications for future use of the TAM

Most software programs available for evaluation using TAM are commercial off-the-shelf and have already been rigorously de-bugged by the manufacturers. When applying the TAM to software that is still being modified or tested, it is extremely important to consider the effect on the TAM variables when users encounter system flaws.

The user's perception of the training program quality does have a significant effect on how they rate the TAM variables. Every effort should be made to make the presentation clear, concise, and appropriate for the given audience. A computer for every student would be ideal, though this is often not possible.

5.2 Limitations

Several factors were seen as limitations for this research. The time constraints of the Silver Flag curriculum was a major limitation. The average presentation time was approximately seventy minutes. While this met the requirements for implementing the

TAM, it was far too little exposure if the intention was to have the students use GeoBEST for their beddown plan within the allotted preparation time. This short time frame also prevented validation of the initial TAM results using the follow-up survey. The lack of student usage also limited the amount of feedback they were able to provide on system features. Most comments were based solely on what was seen during the initial presentation.

The sample size of 71 was sufficient to accomplish the TAM analysis, however only 46 of these were the primary intended audience of CE officers and EA's. Again, this number meets the sample size criteria (35), however the reliability of the TAM results, as with any statistical model, decreases as the sample size decreases. Also, the perceptions of the non-officer/EA students were shown to have significant differences (see section 4.7.1).

A third limitation was computer availability and computer problems. Ideally every student would have had a computer to use during the presentation, whether it was a PC or a laptop. As for computer problems, the initial trial run, where all three laptops experienced different errors (discussed in section 3.2.4), was an example of the often unpredictable behavior of GeoBEST when installed on laptops. Problems were certainly not limited to laptops. While presenting GeoBEST to the AFIT CESS Mgt 101 class (see section 4.3.5) on 8 Nov 01 using a desktop computer, errors occurred which did not allow several of the program features to be demonstrated. Although these students completed the initial survey, the data was not included in this research.

5.3 Opportunities for Future Research

As the problems addressed in this research are corrected and GeoBEST continues to mature using the new ArcGIS technology (see section 4.2.13), the program should be evaluated again to examine its new capabilities and features. The TAM is an effective tool for performing this evaluation, though a longer usage period is recommended to take advantage of feedback that can be provided only after first-hand use of the system. It is possible that a bug-free version of GeoBEST would score low on behavioral intentions. The lessons learned from this research certainly require that this follow-on analysis take place for the latest version of GeoBEST.

GeoBEST is a small piece of the GeoBase initiative. New technologies are continually being introduced that could benefit from acceptance theory testing. Outside the realm of evaluating software, implementing the GeoBase initiative presents a multitude of information management issues that could be addressed through scientific research.

5.4 Final Comments

The purpose of this research was to provide a thorough evaluation of GeoBEST using base level CE officers and EA's in a realistic beddown planning scenario. This plan was accomplished, though not as originally intended. Several problems were identified with the program that limited the researcher's ability to fully present it to the Silver Flag students. Perhaps the most significant problems were the GeoBEST program's inability to consistently track assets within the scenarios, and the unpredictable behavior of the program on different computers. The Technology Acceptance Model was implemented using the initial presentation and survey. Despite current problems with GeoBEST, the model was able to provide a strong prediction of the student's behavioral intentions to use program in the future. The original intention was to validate the TAM results using a follow-up survey and a measure of actual usage. This was not possible due to the lack of time for the student's to become familiar with the program.

Beddown planning is a complex series of tasks. Recent advances in computer technology have produced several tools that have potential for application to the beddown planning process. However, these tools must be carefully designed to function properly and more importantly to meet the needs of prospective users. The creators of GeoBEST claim that it has many applications that simplify and streamline the beddown planning process. GeoBEST does in fact incorporate many tools that could be useful to CE planners. However, it also includes numerous design flaws that seriously impair its effectiveness. A new and reportedly improved version of GeoBEST is due for release soon. Are all of the identified design flaws corrected? Does the program load predictably on multiple types and configurations of computers? Does it have the flexibility to be useful for a broad range of beddown requirements? Does the Air Force have a plan to provide the users with adequate training? Finally, will the intended users accept the technology and put it to productive use? All of these questions must be answered in the affirmative before the Air Force employs GeoBEST.

Appendix A: Surveys

This appendix includes each of the surveys used to gather data for this research. Each survey is described briefly below:

- Silver Flag Student Initial: Administered to students immediately following the GeoBEST introductory training on Monday.
- Silver Flag Student Follow-Up: Administered to students after the beddown briefing on Wednesday for the first three classes.
- Silver Flag cadre: Administered to Silver Flag cadre members who had observed the GeoBEST briefing.
- CE Student: Administered to the Silver Flag students after the final training class on 4 Nov 01 and to the AFIT CESS Mgt 101 students on 8 Nov 01.

Silver Flag Student Initial Survey

GeoBEST

Software Evaluation Survey

(Student Initial)

Purpose: This research is focused on evaluating a beddown planning software program.

Confidentiality: You are a part of a group of Silver Flag students selected to represent the views of base level beddown planners. **Your answers are important.** ALL ANSWERS ARE STRICTLY CONFIDENTIAL and, unless you wish to tell me your identity, all answers are anonymous. No identification of individual responses will occur. I ask for some demographic and other information in order to interpret results more accurately.

Time Required: It will probably take you about 10 to 15 minutes to complete this questionnaire.

Approval: This study has been approved by AFPC with a control number of SCN 01-086. Survey expiration date is 31 Dec 01.

Sponsor: This study is being sponsored by Det 1, 823rd RED HORSE, and the Air Force Civil Engineer Support Agency (AFCESA), Tyndall AFB, FL.

Contact Information: If you have any questions or comment regarding this survey, you may contact either me or my advisor. Thank you very much for your participation.

Sincerely,

//signed//

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Instructions This questionnaire is designed to assess your perceptions of the beddown planning software called GeoBEST following an introductory briefing on its use. Please answer the following questions to the best of your ability.

1. What is your rank?

O AB **O** Amn **O** A1C **O** SRA **O** SSgt **O** TSgt
O MSgt

O 2Lt **O** 1Lt **O** Capt **O** Maj **O** Lt Col **O** Col

O Other ________________

2. What is your branch of service?

O Air Force **O** Army **O** Navy **O** Marines

O Other ________________

3. What is you current status?

O Active Duty **O** Reserve **O** Guard

4. What is your primary AFSC (AF only)?

O 32EXX (Officer) **O** 3E7X1 (Fire Protection)
O 3E5X1 (Engineering) **O** 8F000 (First Sgt)
O 3E6X1 (Operations) **O** Other ______________

5. What is you current job title? ____

6. In general, how often are you required to produce beddown plans (or contribute to portions of a plan)?

O Never **O** Rarely **O** Occasionally **O** Frequently

7. How would you describe your personal level of beddown planning ability?

O No ability **O** Novice **O** Intermediate **O** Expert

8. How would you describe the introductory training you just received on GeoBEST?

O Useless **O** Insufficient **O** Adequate **O** Useful **O** Very useful

9. Do you have any recommendations for improving the training?

10. How would you describe your personal level of preparedness to begin using GeoBEST?

O Very Unprepared **O** Unprepared **O** Slightly Unprepared **O** Slightly Prepared **O** Prepared **O** Very Prepared

For questions 11 through 26, please circle the response that you feel is most appropriate.

11. I enjoy using computers.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

12. I find a computer easy to use.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

13. Using GeoBEST is a(n) _______ idea.

Extremely Good	Quite Good	Slightly Good	Neither good nor bad	Slightly bad	Quite Bad	Extremely Bad

14. I intend to use GeoBEST for beddown planning.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

15. Learning to operate GeoBEST would be easy for me.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

16. Using GeoBEST would improve my performance as a beddown planner.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

17. Using GeoBEST is a ________ idea.

Extremely Wise	Wise	Slightly Wise	Neither Wise Nor Foolish	Slightly Foolish	Foolish	Extremely Foolish

18. I intend to use GeoBEST frequently for beddown planning.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

19. I would find it easy to get GeoBEST to do what I want it to do.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

20. Using GeoBEST would increase my productivity as a beddown planner.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

21. I ______ the idea of using GeoBEST

Strongly Like	Like	Slightly Like	Don't care about	Slightly Dislike	Dislike	Strongly Dislike

22. Using GeoBEST would be ________.

Extremely Pleasant	Quite Pleasant	Slightly Pleasant	Neither Pleasant Nor Unpleasant	Slightly Unpleasant	Quite Unpleasant	Extremely Unpleasant

23. It would be easy for me to become skillful at using GeoBEST.						
Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely
24. Using GeoBEST would enhance my effectiveness in beddown planning.						
Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely
25. I would find GeoBEST easy to use.						
Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely
26. I would find GeoBEST useful for beddown planning.						
Extremely Likely	Quite Likely	Slightly Likely	Neither	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

27. Do you have any additional comments?

This completes this portion of the survey. Prior to the beddown briefing on Wednesday, a follow-up survey will be administered. In order to match your responses on this survey to those on the follow-up survey, please enter the following information:

First two letters of mother's first name: ____ ____

First two letters of father's first name: ____ ____

Privacy Notice
In accordance with AFI 37-132, Paragraph 3.2, the following information is provided as required by the Privacy Act of 1974:
Authority: 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by AFI 36-2601, Air Force Personnel Survey Program.
Purpose: To obtain information regarding user perceptions of a beddown planning software program. Surveys will be administered to students attending training at the Silver Flag training site, Tyndall AFB, FL.
Routine Use: No analysis of individual responses will be conducted and only members of the research team will be permitted access to the raw data. A final report will be provided to Silver Flag Exercise Site, Detachment 1, RED HORSE Squadron, and the Air Force Civil Engineer Support Agency, Tyndall AFB, Florida.
Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not particip ate in this survey or who does not complete any part of the survey.

Silver Flag Student Follow-Up Survey

U.S. AIR FORCE

GeoBEST

Software Evaluation Survey

(Student Follow-Up)

Purpose: This research is focused on evaluating a beddown planning software program.

Confidentiality: You are a part of a group of Silver Flag students selected to represent the views of base level beddown planners. **Your answers are important.** ALL ANSWERS ARE STRICTLY CONFIDENTIAL and, unless you wish to tell me your identity, all answers are anonymous. No identification of individual responses will occur. I ask for some demographic and other information in order to interpret results more accurately.

Time Required: It will probably take you about 10 to 15 minutes to complete this questionnaire.

Approval: This study has been approved by AFPC with a control number of SCN 01-086. Survey expiration date is 31 Dec 01.

Sponsor: This study is being sponsored by Det 1, 823rd RED HORSE, and the Air Force Civil Engineer Support Agency (AFCESA), Tyndall AFB, FL.

Contact Information: If you have any questions or comment regarding this survey, you may contact either me or my advisor. Thank you very much for your participation.

Sincerely,

//signed//

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DSN 785-3636 x4800

This portion of the survey is to be completed after the beddown planning exercise.

1. Did you contribute to the preparation of the beddown plan?

   O Yes (please continue)

   O No (please skip to question 20)

2. Did you use GeoBEST to assist in preparation of the beddown plan?

   O Yes (please continue)

   O No (please skip to question 20)

3. Indicate which GeoBEST features you used (mark all that apply).

   O Calculate asset requirements based on number of aircraft or population
   O Import imagery as a theme
   O Area analysis (number of assets that will fit within a defined area)
   O Allocate assets within a scenario
   O 3D viewer
   O Constraints analysis (dispersed/non-dispersed facility distances)
   O Map generator
   O Import saved scenario into the current scenario
   O Rescale image (based on image resolution or object size)
   O Image registration (merge image file with data file)
   O Metadata (asset information such as text or pictures)
   O Report generator
      O All Scenarios report
      O Facilities/Equipment Inventory report
      O Deployment Package Inventory report
      O Labor Requirements report
      O Power Requirements report
   O Scheduler (ad-hoc 30 day schedule)
   O Asset labeling
   O Drawing tools (lines, circles, etc.)
   O Database Editor
   O Import GPS data files
   O On-line Help (GeoBEST or ArcView)
   O Other ___________________________

For questions 4 through 17, please circle the answer that you feel is most appropriate.

4. Using GeoBEST is a(n) _______ idea.

Extremely Good	Quite Good	Slightly Good	Neither good nor bad	Slightly Bad	Quite Bad	Extremely Bad

5. I intend to use GeoBEST for beddown planning.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

6. Learning to operate GeoBEST is easy for me.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

7. Using GeoBEST improves my performance as a beddown planner.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

8. Using GeoBEST is a(n) ________ idea.

Extremely Wise	Wise	Slightly Wise	Neither Wise Nor Foolish	Slightly Foolish	Foolish	Extremely Foolish

9. I intend to use GeoBEST frequently for beddown planning.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

10. I find it easy to get GeoBEST to do what I want it to do.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

11. Using GeoBEST increases my productivity as a beddown planner.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

12. I ______ the idea of using GeoBEST

Strongly Like	Like	Slightly Like	Don't care about	Slightly Dislike	Dislike	Strongly Dislike

13. Using GeoBEST is ________.

Extremely Pleasant	Quite Pleasant	Slightly Pleasant	Neither Pleasant Nor Unpleasant	Slightly Unpleasant	Quite Unpleasant	Extremely Unpleasant

14. It is easy for me to become skillful at using GeoBEST.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

15. Using GeoBEST enhances my effectiveness in beddown planning.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

16. I find GeoBEST easy to use.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

17. I find GeoBEST useful for beddown planning.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

18. Approximately how much time did you spend PERSONALLY using GeoBEST (ie. you were the one operating the system)?

O Less than one hour
O One to two hours
O Two to three hours
O Three to four hours
O More than four hours (estimate: _____ hrs.)

19. Approximately how much time did you spend as part of a group using GeoBEST?

O Less than one hour
O One to two hours
O Two to three hours
O Three to four hours
O More than four hours (estimate: _____ hrs.)

20. What features of GeoBEST do you like the most? Why?

21. What features of GeoBEST do you like the least? Why?

22. What suggestions do you have for future improvements of GeoBEST?

23. Now that you have used GeoBEST, how would you describe the introductory training you received?

O Useless **O** Insufficient **O** Adequate **O** Useful **O** Very useful

24. Do you have any recommendations for improving the training?

25. Do you have any additional comments?

Thank you for your participation. Please enter the following information to link your responses to those on the initial survey.

First two letters of mother's first name: ____ ____

First two letters of father's first name: ____ ____

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Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not participate in this survey or who does not complete any part of the survey.

Silver Flag Cadre Survey

GeoBEST

Software Evaluation Survey
(Silver Flag Cadre)

Purpose: This research is focused on evaluating a beddown planning software program.

Confidentiality: You are a part of a group of Silver Flag instructors or staff members selected to represent the views of beddown planning experts. **Your answers are important.** ALL ANSWERS ARE STRICTLY CONFIDENTIAL and, unless you wish to tell me your identity, all answers are anonymous. No identification of individual responses will occur. I ask for some demographic and other information in order to interpret results more accurately.

Time Required: It will probably take you about 10 minutes to complete this questionnaire.

Approval: This study has been approved by AFPC with a control number of SCN 01-086. Survey expiration date is 31 Dec 01.

Sponsor: This study is being sponsored by Det 1, 823rd RED HORSE, and the Air Force Civil Engineer Support Agency (AFCESA), Tyndall AFB, FL.

Contact Information: If you have any questions or comment regarding this survey, you may contact either me or my advisor. Thank you very much for your participation.

Sincerely,

//signed//

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Note: Each participating cadre member should complete this survey only once.

1. What is your current position at Silver Flag?

   O Instructor
      O Command & Control
      O Engineering
      O Fire Protection
      O Other ___________________
   O Other ___________________

2. How long have you been assigned to Silver Flag?

   O Less than one year
   O One to two years
   O Two to three years
   O More than three years

3. Based on your experience, how would you rate the performance (with regard to beddown planning) of Silver Flag students who use GeoBEST versus students using traditional methods?

   O Much worse
   O Worse
   O About the same
   O Better
   O Much better

4. What are the major differences (if any) between plans produced using GeoBEST and those produced with traditional methods?

5. If you viewed the GeoBEST introductory training briefing, how would you rate it?

O Useless **O** Insufficient **O** Adequate **O** Useful **O** Very useful

6. Do you have any recommendations for improving the training?

7. What features of GeoBEST do you like the most?

8. What features of GeoBEST do you like the least?

9. What suggestions do you have for future improvements of GeoBEST?

10. Do you have any additional comments?

Thanks for your participation!

Privacy Notice
In accordance with AFI 37-132, Paragraph 3.2, the following information is provided as required by the Privacy Act of 1974:
Authority: 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by AFI 36-2601, Air Force Personnel Survey Program.
Purpose: To obtain information regarding user perceptions of a beddown planning software program. Surveys will be administered to students and instructors at the Silver Flag training site, Tyndall AFB, FL.
Routine Use: No analysis of individual responses will be conducted and only members of the research team will be permitted access to the raw data. A final report will be provided to Silver Flag Exercise Site, Detachment 1, RED HORSE Squadron, and the Air Force Civil Engineer Support Agency, Tyndall AFB, Florida.
Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not participate in this survey or who does not complete any part of the survey.

Silver Flag Student Survey (revised for 4 Nov 01)

GeoBEST

Software Evaluation Survey
(Student)

Purpose: This research is focused on evaluating a beddown planning software program.

Confidentiality: You are a part of a group of Civil Engineering students selected to represent the views of base level beddown planners. **Your answers are important.** ALL ANSWERS ARE STRICTLY CONFIDENTIAL and, unless you wish to tell me your identity, all answers are anonymous. No identification of individual responses will occur. I ask for some demographic and other information in order to interpret results more accurately.

Time Required: It will probably take you about 10 minutes to complete this questionnaire.

Approval: This study has been approved by AFPC with a control number of SCN 01-086. Survey expiration date is 31 Dec 01.

Sponsor: This study is being sponsored by Det 1, 823rd RED HORSE, and the Air Force Civil Engineer Support Agency (AFCESA), Tyndall AFB, FL.

Contact Information: If you have any questions or comment regarding this survey, you may contact either me or my advisor. Thank you very much for your participation.

Sincerely,

//signed//

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Instructions
This questionnaire is designed to assess your perceptions of the beddown planning software called GeoBEST following an introductory briefing on its use. Please answer the following questions to the best of your ability.

1. What is your rank?

O AB **O** Amn **O** A1C **O** SRA **O** SSgt **O** TSgt
O MSgt

O 2Lt **O** 1Lt **O** Capt **O** Maj **O** Lt Col **O** Col

O Other ________________

2. What is your branch of service?

O Air Force **O** Army **O** Navy **O** Marines

O Other ________________

3. What is you current status?

O Active Duty **O** Reserve **O** Guard

4. What is your primary AFSC (AF only)?

O 32EXX (Officer) **O** 3E7X1 (Fire Protection)
O 3E5X1 (Engineering) **O** 8F000 (First Sgt)
O 3E6X1 (Operations) **O** Other ______________

5. What is you current job title? ____

6. In general, how often are you required to produce beddown plans (or contribute to portions of a plan)?

O Never **O** Rarely **O** Occasionally **O** Frequently

7. How would you describe your personal level of beddown planning ability?

O No ability O Novice O Intermediate O Expert

8. How would you describe the introductory training you just received on GeoBEST?

O Useless O Insufficient O Adequate O Useful O Very useful

9. Do you have any recommendations for improving the training?

10. How would you describe your personal level of preparedness to begin using GeoBEST?

O Very Unprepared O Unprepared O Slightly Unprepared O Slightly Prepared O Prepared O Very Prepared

For questions 11 through 26, please circle the response that you feel is most appropriate.

11. I enjoy using computers.						
Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree
12. I find a computer easy to use.						
Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree
13. Using GeoBEST is a(n) _______ idea.						
Extremely Good	Quite Good	Slightly Good	Neither good nor bad	Slightly bad	Quite Bad	Extremely Bad
14. I intend to use GeoBEST for beddown planning.						
Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

15. Learning to operate GeoBEST would be easy for me.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

16. Using GeoBEST would improve my performance as a beddown planner.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

17. Using GeoBEST is a ________ idea.

Extremely Wise	Wise	Slightly Wise	Neither Wise Nor Foolish	Slightly Foolish	Foolish	Extremely Foolish

18. I intend to use GeoBEST frequently for beddown planning.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

19. I would find it easy to get GeoBEST to do what I want it to do.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

20. Using GeoBEST would increase my productivity as a beddown planner.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

21. I ______ the idea of using GeoBEST

Strongly Like	Like	Slightly Like	Don't care about	Slightly Dislike	Dislike	Strongly Dislike

22. Using GeoBEST would be ________.

Extremely Pleasant	Quite Pleasant	Slightly Pleasant	Neither Pleasant Nor Unpleasant	Slightly Unpleasant	Quite Unpleasant	Extremely Unpleasant

23. It would be easy for me to become skillful at using GeoBEST.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

24. Using GeoBEST would enhance my effectiveness in beddown planning.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

25. I would find GeoBEST easy to use.

Extremely Likely	Quite Likely	Slightly Likely	Neutral	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

26. I would find GeoBEST useful for beddown planning.

Extremely Likely	Quite Likely	Slightly Likely	Neither	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

27. What features of GeoBEST do you like the most? Why?

28. What features of GeoBEST do you like the least? Why?

29. What suggestions do you have for future improvements of GeoBEST?

30. Do you have any additional comments?

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Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not participate in this survey or who does not complete any part of the survey.

Appendix B: Student Survey Qualitative Feedback

This appendix contains the qualitative feedback provided on the Silver Flag student surveys. Students provided responses to the following questions:

- Do you have any recommendations for improving the training?
- What features of GeoBEST do you like the most? Why?
- What features of GeoBEST do you like the least? Why?
- What suggestions do you have for future improvement of GeoBEST?
- Do you have any additional comments?

Student Survey Qualitative Feedback

"Do you have any recommendations for improving the training?"
Allow a longer block of time. One hour was not enough.
More Time
Need a detailed hand-out.
Allow for automatic corrections of spacing
More hands on for all participants
If it is to be used Air Force wide more than 1 hour of training is needed.
Allow a little more time and a "play around with it" period. Too fast.
More time and hands on training.
Deploy to AirNG sites for use/feedback. Demonstrate where database data location in T.O.s. Prove to audience that numbers are accurate.
The easy answer is more time. The schedule just doesn't allow for it. More computers.
More time allotted for training.
Better quality software with more capability. Then more instruction and benefit.
I attended 1 hour of training. Obviously need more time to learn capabilities and experiment before making an evaluation.
Additional "hands-on" training.
Fire hose course. Use units on data tables. Ie. KW, amps, etc. More flexibility when correcting errors. Not always having to start over.
Longer, hands on.
Needs an undo command that works correctly. Too much starting over. Nice to have some similar commands from AutoCAD ie. Array, snap.
Increase the time to 4 hr min.
More time and more hands on.
Provide a longer training period with more hands on.
Obviously, time constraints dictate. However, a more in depth training class specific to the program would be beneficial.
Formal training class, two weeks, to get familiar with the system.
More practical.
More hands on.
Need 2-3 days of step by step hands-on.
None at this time without using the program.
Good presentation. Individual access to the program for each candidate would be nice.
More time needed for demonstration/instruction.
Longer with hands on.
More time.
Was more overview than training. Actual training should include some hands on practice.
More time on training.
None. It was well explained.
Add vehic le beddown for force protection measures. Possible bitburg and sandbag barriers.

Very good overview and introduction.
More hands-on training.
Lengthen training.
More hands-on training would be useful.
More time, computers to use during training.
Formalize into req'd training.
More computers/hands-on. Specific tasks/homework. Not enough time.
Need a computer at every seat.
It's hard to really understand the tool without actually using it. Hands on training would be very beneficial.
Allocate more time and hands-on training.
There was no hands-on training. It was strictly a point and click show.
I believe that a background in GIS would be necessary to fully appreciate this software.
Could have representative from the contractor present for questions.
More time. Hands on.
Technical and instructional data must be disseminated among students to become familiar with features and its capabilities. It looks like a very promising tool because it has the capability of growing at a proportionate rate with the user's capabilities and available information. It can minimize greatly the amount of time spent in preparing a beddown plan, provided it can assimilate all the required information.

"What features of GeoBEST do you like the most? Why?"
Database and that layout can be done over drawing or aerial photo.
With some additional training and familiarization GeoBEST will be a great tool for beddown planning.
Analysis, allocate assets, and map generator.
3D and programming. With 3D you can see it in a cool way. Programming is good for those who start OJT. It has everything you need to know for starters there.
The ability to put down the number of aircraft you need to support and the program producing all the assets needed for the deployment.
Database and construction times, specs on equipment, etc.
The system using layers allows you to put just the information you need.
Visualization of the plans. 3D views. Being able to use picture overlay.
The siting and rotational capability. I liked the overall capability of GeoBEST because it has a lot of range on layouts and scenarios. Less complicated to work with than AutoCAD.
The program is all-encompassing.
The lay over feature of drawings and pictures [image registration].
Tie in of 10-219, 10-222 asset info into scaled map with intelligent points. Will allow to have picture vs. endless paragraphs of text and tables.
It will be a great tool eventually, but it's not quite there yet. I'm sure the updated version will be improved.
Most of its features/capabilities I liked. Good tool.

3D. Asset availability.
Mapping image files.
Looked good in the demonstration.
Concept is good.
3D plots. Better impression of camp layout.
3D Features.
Pre-packaged info on assets (access database info)
Didn't use it. Nice because it has the beddown criteria.
Overall I think it will be very helpful.
I like the fact that you can move info from AutoCAD to Picture. Better visual.
Tracing of facilities, 3D.
3D imaging. You can see all the directions you don't on CAD.
Importing an aerial view jpg, and using it to work off of.
3D and panning features.
All aspects of GeoBEST program appear useful.
All the information is there and can be extracted from one software package.
Using fly over photos. Realistic.
Not familiar with program, only saw the introduction to it. Seems like an excellent tool though.
Information data processing. Effective and time saving.
3D effects.
Photo and template integration.
It simplifies the process of laying out the beddown process.
It interacts with AutoCAD.
I liked the ability of the software to use GIS and AutoCAD.
Automation. Any tool that helps with a simplified way of creating a beddown plan I'm in favor of.
Picture access. The ability to rotate and 3D.
Once you have learned how to use GeoBEST, I am pretty sure it can be very effective.
It is flexible. It can be modified to fit any scenario.
Keeping track of asset counts.
Pre loaded database. Seems to have a lot of features and flexibility.
The intelligence and user-friendly controls of the program. The program works with you tracking your design and assisting in correct beddown planning procedures.
3D graphics. Closeness of pictures. Very realistic.
Number crunching. Built-in calculations.
3D
Asset placement, spacing and management of assets placed. Ability to import real world imagery or mapping details.
Keeps up with asset allocation.
It has a lot of items already in its database.
Spacing analysis for assets because spacing is a tricky thing to get around.
How easy it is to use, it wouldn't take much time to learn and apply it to do beddown planning or even on other projects.

The use of real-time photo imagery and automatic calculations based on a database.
3D
Graphical presentation of base layout.
Without actually trying GeoBEST I find it hard to provide an accurate description of what I would use if for and how easy it would be to use.
Pictures, images. Being able to plot the assets and the program calculating man-hours, inventory, etc.
The relational database is quite appealing.
How easy it is.
The inventory, because you then know how many you've used.
All (nearly) assets are already programmed in. The scenario wizard. Ease of importing images and dwg's.
GIS capabilities, real world inputs can be added, 3D features, ease of use to do presentations.

"What features of GeoBEST do you like the least? Why?"
Not easy to layout lines to keep facility layout placement in line.
Line commands. Need to be able to draw a line to a specific length.
Due to being unfamiliar with GeoBEST it was more time consuming than the traditional methods for the exercise.
Functions. Unlike AutoCAD you can't type in what you want to do. You have to drag/click. That takes up to much time.
None
Didn't get to use it enough to say.
Being able to site facilities with the distance criteria.
Requirements of putting drawings to scale in feet or meters. Using AutoCAD files in different units would allow for use during this exercise. Would not correct siting mistakes.
I would like to see more unique or recognizable icons to simplify its use.
At present, it is limited to two bases.
The scales put in it. Should be more expanded.
Not developed enough to adequately test use. Too many little (simple) issues create more questions than progress.
Needs an undo feature. Not enough aircraft specific data (ie. Dimensions, dimensions with revetments, etc.)
Not familiar enough with the product to comment.
Not able to move around very easily.
3D fly-by feature is single speed (too fast to view), which renders this feature useless. Scale.
Don't have enough info to evaluate
Not as user friendly as it needs to be.
Labor intensive.
"start overs" rather than "go back to previous saved"

Drawing portion. Takes longer than AutoCAD due to commands.
Didn't track inventory.
Not able to generate any limfacs/shortages.
That you can't match orientations [image registration].
The unavailability to have AutoCAD files updated from the original, when brought into GeoBEST. [xref]
Have not used program enough to dislike any features.
Use of dispersed assets. Should include non-dispersed.
Too complicated.
Should be use assistance.
Not able to cut and paste everything or do copy on everything.
All features are outstanding.
Haven't used it enough to know.
It seems like it would take a lot of training to get efficient with the program.
The inability for the program to import DWG files in a 1 to 1 scale.
3D.
Must set up dwq files prior to using this software.
Accuracy for mapping purposes and surveying.
Lack of force-protection measures.
Will not insert a dispersed or nondispersed layout into a selected area [area analysis].
Icons
Not enough time to evaluate.
I don't see any drawbacks at this introductory level.
The inability to auto plot an area once the limits have been defined.
The CRASH feature.
Did not receive enough info to answer this question.
One would need to invest the time to properly learn ArcView in advance to master this software.
Scaling, because I didn't get it.
Scaling. I had a hard time.
None so far, provided it can grow with this troop's needs.

"What suggestions do you have for future improvement of GeoBEST?"
More instruction on how to use it.
See question above. When "copying an object allow user to "paste" the copied object where they would like it. Not on top of the old one.
More user friendly.
Great tool. Need more time to learn.
If a class is given, give some more time space for learning.
Adapt it to the different services.
Didn't get to use it enough to say.

Incorporate the GPS ability into the briefing.
Add aircraft templates and information (ie. Wingspan, dimensions). Add hardening assets such as B-1. Add CCD assets. Correct siting mistakes.
A self-help program, after a more in-depth class.
Need more time to play with it to answer this.
Hope to get a full blown training before or if even it gets implemented.
Undo, variable birds eye speed, sample beddown plans of at least 1100 person team, one with joint forces, combined aircraft (for entire area, not just individual assets)
Same as #21.
Move toward AutoCAD function.
Make it much more user-friendly prior to fielding. Also ensure that Harvest asset packages are not modified/obsolete prior to fielding this software.
Develop a more user friendly system. Incorporate basic electrical, utilities, etc. that can determine layout options based on information you input.
More flexible with correcting mistakes without rebooting.
More features to eliminate repetitive tasks or having it build base line packages. Time is a constraint.
Improve drawing options. Object snaps. Undo instead of Redo.
Track inventory shortfalls.
From above, have capability for updates from CAD files to be effective in GeoBEST.
It is difficult to use GeoBEST under the very short time allotted to plan beddown. Once the system is implemented force wide, the use at Silver Flag would be beneficial. Most of the individuals I spoke with felt that given the time constraints, GeoBEST was not the program to use. Spin up time would take too long.
Make it simple.
Interact with total station.
Get it out to the users.
Be able to integrate with AutoCAD more easily and effectively.
Didn't use it, so I'm not completely familiar w/ capabilities or weaknesses.
Does it have a built-in self-help window? That would be helpful.
Have the ability to meld with AutoCAD.
Ensure flexibility to add vehicles, equipment, and other features relatively easily.
After notifying you of conflicts is should automatically resolve the spacing issues, or ask if you want it to resolve them.
These surveys are not good. Their questions are alike. Repetitive.
Add vehicles/equipment/barriers.
Integration with a base's GeoBase system or TBMCS.
Needs to work more effectively with AutoCAD.
It seems that it would be better run with AutoCAD.
I think it's a great program, but more people AF-wide need to properly know how to use it. If that doesn't happen than this program will not receive its maximum usage.
Allow to export DWG files.
Obtaining a copy for homestation for trng.
Include modules for vehicles and equipment.

Get a better scaling feature.
When an analysis is performed – it completes the drawing.
I would like to see some capabilities expanded. Ease of conversion of units, importing AutoCAD and Microstation smart maps and any associated information. Vast distribution among the AF community.

"Do you have any additional comments?"
Great idea/tool!
Add breaks in your lesson to keep attention of students.
Make it adaptable to USMC gear.
Need more training or exercises using GeoBEST to make a true and accurate evaluation
Hard to tell at this time. Too new.
Extremely useful program for more than just beddown planning. It would take some time, but I could learn to use this program.
Need some better features involving undo options and ability of movement for objects within the scenario.
If more user friendly would be a good tool.
Add ability to place multiple assets at a time vs. having to place each one individually. On conflict option add "fix" step to correct identified conflicts.
Would be very useful when some of the glitches are worked out.
Changes to maps should update base plan. Need auto save feature. Common files import/export should be with coordinates.
Excellent presentation.
The lesson was good for the amount of time slated.
Adapt it to USMC gear.
Make sure it will run on Win 98, NT, & 2000.
Did not get enough hands-on in class to get a fair estimate of the capabilities of the product. The idea of the program is a good idea.
Send a trial copy to EA's at bases for them to decide, they are the ones that will be using it the most.
I am very interested in seeing this product.
Unfortunately unable to use system due to lack of time to learn system. If used AF wide this may be a good tool. Do not suggest use unless standardized across the AF. Thanks!
Very useful program if some little glitches were fixed.
If we (the base level engineers) use this program then an all inclusive software package should be sent.
As an operations technician, I feel I would never use GeoBEST. But I am sure the Engineering section would find it very useful.
Based on the short intro I think it will be an excellent tool, as long as adequate training in available along with the software. It's difficult to say how easy it will be to learn based on such a short intro.

I like the program and would like the chance to become more familiar with it.
GeoBEST seems as though it could be a useful tool in beddown planning. I would have to see more of this program before I could make a real informed decision.
The Capt was a great teacher for such a short time period. Thanks.
Good presentation!

Appendix C: Cadre Survey Qualitative Feedback

This appendix contains the qualitative feedback provided on the Silver Flag cadre surveys. These surveys were administered after the final Silver Flag class on 4 Nov 01. Cadre members provided responses to the following questions:

- Do you have any recommendations for improving the training?
- What features of GeoBEST do you like the most?
- What features of GeoBEST do you like the least?
- What suggestions do you have for future improvement of GeoBEST?
- Do you have any additional comments?

Cadre Survey Qualitative Feedback

"Do you have any recommendations for improving the training?"
GeoBEST is very similar to AutoCAD and there's just not enough time for the student hands-on required to learn the system. Recommend this be primarily a home station training requirement, but that we include GeoBEST orientation at Silver Flag.
Familiarization training is good for "gee whiz" info…I can imagine that training held for actual usage of software would be quite entailed.
Need more in-depth training and practice time for students.
Really, the only thing I would change would be switching the "fly-by"command to an "undo" command. Fly-by is a nice visual to have, but undo would get a lot more use.

"What features of GeoBEST do you like the most?"
It is a very USEFUL tool - once you know how to use it. It makes beddown planning faster/easier.
Tracking of assets and ensuring proper distances between facilities/groups.
Automatic tracking of placed assets.
3D is always nice when presenting presentation to be briefed.

"What features of GeoBEST do you like the least?"
The menus and icons are difficult to navigate because they're not "standard" (like other operating systems). It takes too many "clicks" to open a file to work in.
No preset facility groups (such as 24-tent non-dispersed layout)

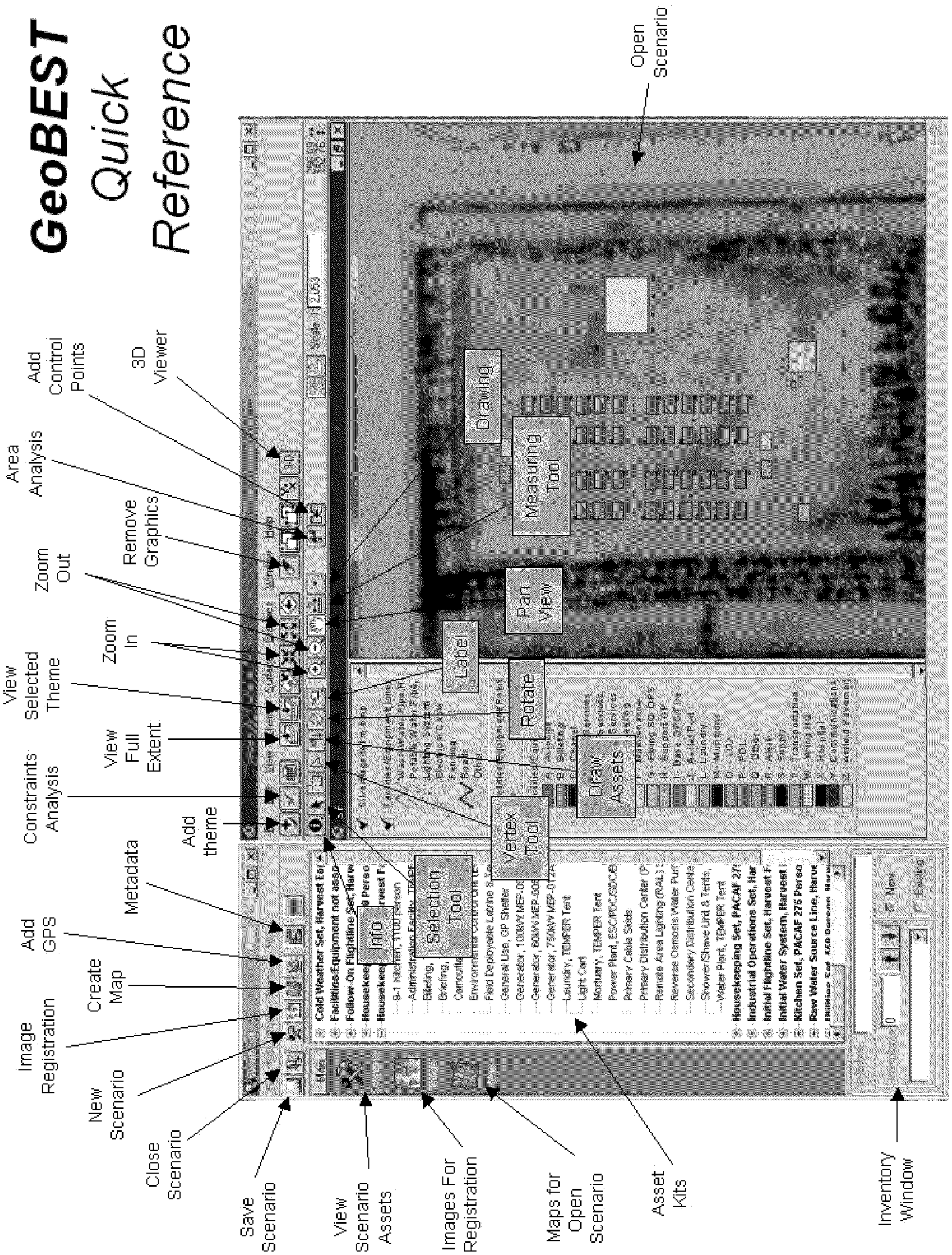
"What suggestions do you have for future improvements of GeoBEST?"
Move more towards point-and-click options instead of all the pull down menu options.
PLEASE give me an "undo" button.
Need groups of structures in non-dispersed layout.
Have a command of an option that will let you place entire Temper Tent and Alaskan Small Shelter block (I don't recall there being one.)

"Do you have any additional comments?"
I think this system will prove very useful once it's implemented. Officers/EA's in the field just need a good solid week of training on it before they can use it effectively.
Great beddown tool once all units get incorporated.
The entire class was great! Capt Jensen did an outstanding job!

Appendix D: GeoBEST Quick Reference Handout

This appendix contains the GeoBEST quick-reference handout that was provided to of the Silver Flag students. Two laminated copies of the handout were left with the students for the duration of the beddown planning period between the introductory training on Monday and the beddown briefing on Wednesday.

GeoBEST Quick Reference Handout



Appendix E: Silver Flag Student Handout

This appendix contains the GeoBase informational handout that was provided to each of the Silver Flag students. GeoBase is introduced followed by a thorough description of GeoBEST. Distribution of this handout was not part of the original evaluation plan, but was recommended by the cadre members.

Silver Flag Student Handout

The GeoBase Concept

Presentation by Capt Shawn Jensen, AFIT/GEEM

In the fall of 1998 representatives from the communications and information management community met with civil engineer agencies to explore how the two functional missions could better share geospatial information resources. The desired outcome of the GeoBase effort is to ensure each USAF installation has the organic capacity to access, exploit, and maintain one geospatial information infrastructure supporting multiple mission needs.

Based on proven, commercial off-the-shelf (COTS) computer hardware and software (ESRI™ ArcView), GeoBase provides a Common Installation Picture. It is not a "system" in the sense of a software package such as Microsoft™ Office, but is more of a concept based on integrating multiple data sets into a common architecture using proven geospatial technology. The applications of GeoBase are numerous. It can be used to provide daily mission support for facility management, airfield operations, explosive safety siting, and communications maintenance. Emergency services can use the tool to plot cordons around emergency sites and reroute traffic flow. Airfield obstructions can be managed to a higher degree of accuracy providing aircrews with a better visualization of the airfield. Communications cables and utility lines can be located to a higher degree of accuracy when performing construction, preventing unscheduled outages. All base users would be working from the same data sets, ensuring that the current information is up-to-date and accurate. Figure 1 is an example of a GeoBase emergency response tool in use at Moody AFB, Georgia. Automated screens prompt users for information about facility numbers, size of cordon needed, traffic rerouting, and several other features.

With FY02 AF funding, it is expected that GeoBase foundation data and core applications can be acquired and implemented at all USAF installations within two years. The next step will be DoD-wide implementation and further development of the GeoReach concept, which takes the functionality of GeoBase and adds a virtual toolkit of planning, analysis, and communications software for use at a bare base or other forward operating locations. GeoReach is essentially a deployable version of GeoBase and includes a Contingency Aircraft Parking Planner (CAPP) and a bare base planning tool called GeoBEST. The following section describes this program in detail.

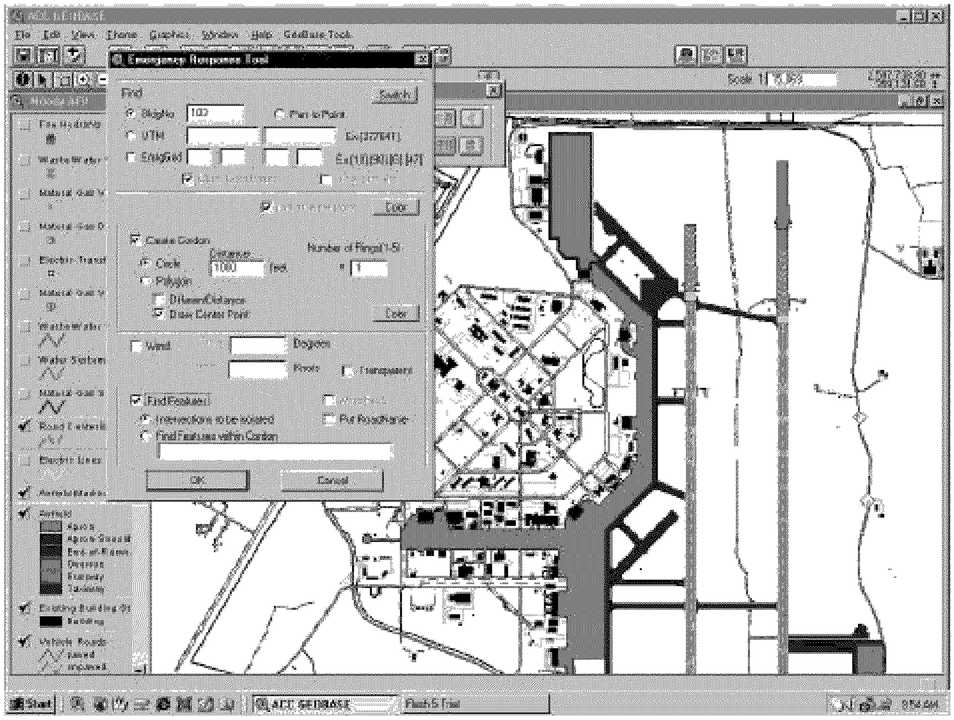


Figure 1: GeoBase Emergency Response Tool

GeoBEST

GeoBEST (Base Engineering Survey Toolkit) is a PC-based GIS application designed to give the user the ability to view the spatial extent of a selected location. They can then match the resources to be deployed with the appropriate locations in a spatial configuration that conforms to established siting standards. GeoBEST was created by BTG Delta Research Division, Niceville, FL under the name Bare Base Conceptual Planning System (BBCPS). It was later renamed GeoBEST to help identify it as a part of the GeoReach program. Initially developed for use in the Pacific Air Force (PACAF) theater of operations, GeoBEST provides the deployment planners with an automated, interactive, computer-based tool for rapid development of base layout plans. This can be applied to any location for which imagery is available. The application allows the user to import various types of imagery and locate each of the facilities required at the identified location in response to a defined scenario. Following is a more detailed description of the program including some images of GeoBEST in use.

Like GeoBase and GeoReach, GeoBEST is based on commercially available off-the-shelf software. The user interface, created with Microsoft™ Visual Basic, interacts with ESRI™ ArcView and a Microsoft™ Access database. The GeoBEST interface consists of a split screen, with the Visual Basic window on the left and the ArcView window on the right, as shown in Figure 2.

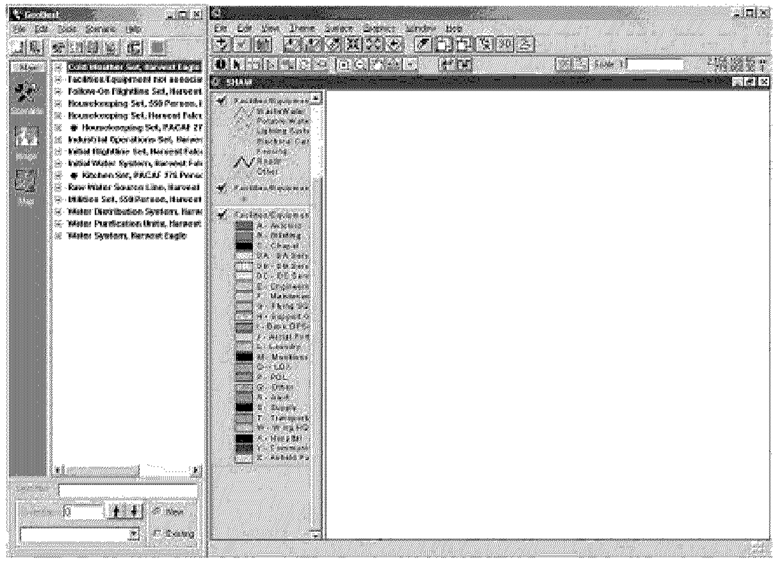


Figure 2: GeoBEST user interface

When working with GeoBEST, the user's work will be saved as a "scenario." Each scenario stores the data sets (imagery, assets, etc.), inventory and number of allocated assets, and map layouts. Users initially have the option of either opening an existing scenario or creating a new one. GeoBEST comes with eighteen pre-made scenarios (without imagery) based on the dispersed facility layouts shown in AFPAM 10-219, Vol. 5, Attachment 15. These can be used on their own or imported into other scenarios. When creating a new scenario, the user may elect to create a blank scenario (inventory and deployment packages set to zero) or use the scenario wizard. Blank scenarios are primarily intended for creation of new templates. The scenario wizard walks the user through the development of a scenario that will generate the recommended asset kits based on the entry of a base population and/or selected aircraft types and quantities. The user has the option of accepting the recommended asset quantities or modifying them if the exact quantities are known. Once a new scenario is created, the user may display the individual asset inventories within each kit. If the wizard was used, GeoBEST automatically calculates the number of individual assets needed based on the aircraft number or population. Again, the user may accept these quantities or modify them as needed.

Scenarios in GeoBEST may consist of only the allocated assets or the user may add additional data sets depending on what is available and what information is needed about the site. ArcView has the capability of integrating a variety of different data sets, including AutoCAD files, shape files, Intergraph Design files, image formats (jpg, bmp, tif, sid, gif, etc.), GPS data sets, and many more. Each data set is added as a "theme," which could be thought of as a layer. The different themes may be displayed or hidden as needed. The GeoBEST database stores the dimensions of each deployable asset (length, width, and height) in terms of its footprint (ie. the space it occupies as opposed to its actual shape). In order to ensure the allocated assets are scaled correctly, the user must specify the map units. This is obviously dependent on the data sets that are being used as background themes. GeoBEST is capable of working in meters or feet. ArcView has the capability of re-scaling image files based on the image resolution or the dimensions of an object displayed in the image (size of a building or width of a runway). ArcView 3.2 does not have the ability to rotate the images. Figure 3 below shows an open scenario with allocated assets and a bitmap image as the background theme.

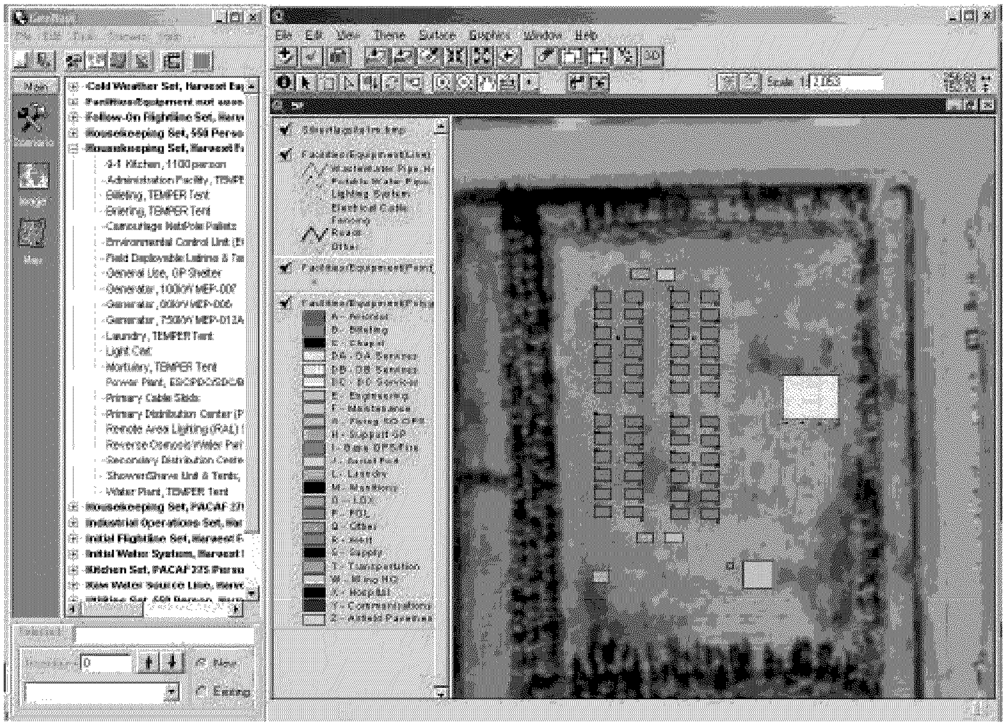


Figure 3: Open GeoBEST Scenario

Once assets have been added to a scenario, they may be rotated or grouped with other assets. GeoBEST Constraints Analysis tool has the ability to analyze groups of facilities to determine if they meet the distance requirements for non-dispersed and dispersed layouts. For example, there should be at least 12 feet between billeting TEMPER tents in a non-dispersed layout. Areas within the scenario can be analyzed to determine the number of a particular asset that will fit within the designated area (dispersed and non-dispersed).

GeoBEST includes metadata (additional information) for many of the individual assets. Most assets have a text description and many also have an image. GeoBEST allows the user to add text, image, audio and video files for individual assets if they are available. Figure 4 below is an example of metadata for a Harvest Falcon MEP-012 generator, which is included with the current version of GeoBEST.

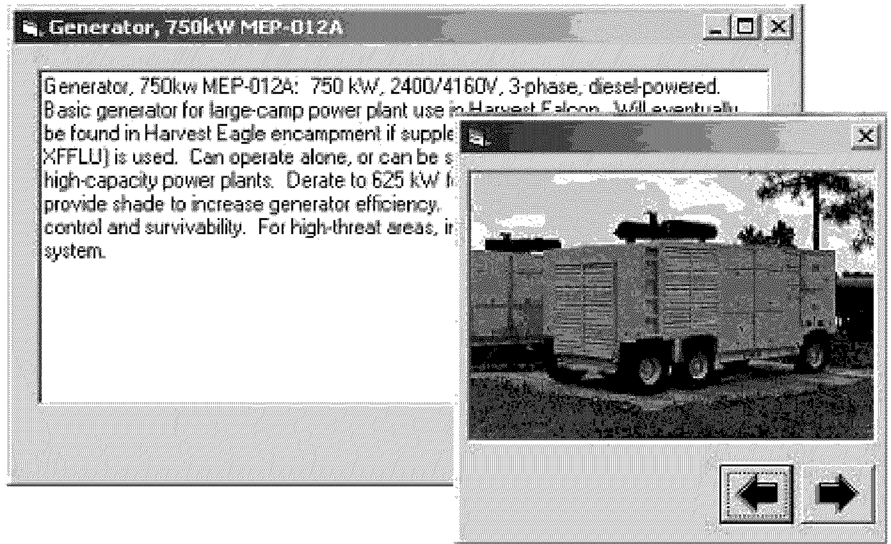


Figure 4: Metadata text and image for MEP-012

GeoBEST has the ability to display scenarios in a three-dimensional format. The user can pan, zoom, or rotate the 3D image to view particular areas or even select a continuous "fly-around" view. The current view can be saved as a JPEG or BMP image for importing into documents or presentations. Figure 5 below is an example of a 3D view, showing the scenario displayed in Figure 11.

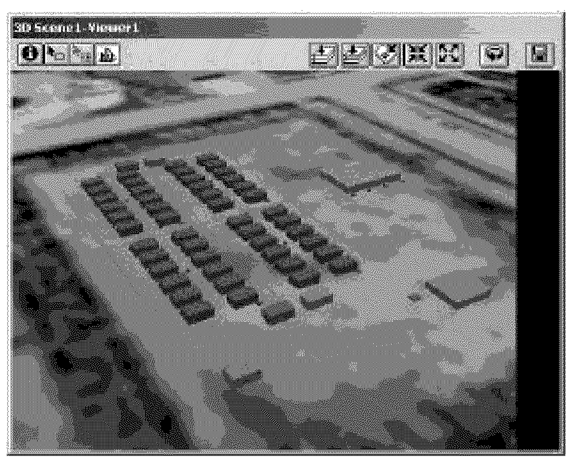


Figure 5: Scenario 3D View

The GeoBEST report generator allows the user to create custom reports relating to all assets or currently allocated assets in the active scenario. Currently, GeoBEST offers five types of reports. These include All Scenarios, Facilities/Equipment Inventory, Deployment Package Inventory, Labor Requirements, and Power Requirements.

- All Scenarios: This report lists all scenarios that have been created and their general information, which includes the scenario ID, name, population, directory location, date, created, date modified, and the user who created it.
- Facilities/Equipment Inventory: This report contains information regarding the current scenario assets. This report includes general information about the current scenario as described above (asset name, number inventoried, number allocated, and number recommended). The report can display all assets in the selected deployment packages or just the currently allocated assets in the view.
- Deployment Package Inventory: This report contains information regarding the deployment packages related to scenarios that were selected during the initial creation of the scenario. The report includes general information about the current scenario as described above (the asset name and which deployment package it belongs to). This report can only display all assets in the selected deployment.
- Labor Requirements: This report contains information regarding the labor hours required per asset. The report includes information pertaining to the current scenario (asset name, number allocated, required labor hours, total required labor hours, and a description of the type of labor required). This report can display all assets in the selected deployment packages or just the currently allocated assets in the view.
- Power Requirements: This report contains information regarding the power required per asset in kilowatt-amperes. This report includes general information for the current scenario (asset name, number allocated, normal power voltage, total normal power voltage, air conditioning voltage, and total air conditioning voltage). This report can display all assets in the selected deployment packages or just the currently allocated assets in the view.

GeoBEST includes the ability to manage the database. Users can modify information about the deployment kits, modify or add/delete individual assets, adjust the number of personnel associated with each type of aircraft, or correct any deficiencies or inaccurate information.

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Vita

Captain Shawn J. Jensen was born in Safford, Arizona. He graduated from Dexter High School in Dexter, New Mexico in 1990. He attended New Mexico State University the same year and graduated with a Bachelor of Science Degree in Mechanical Engineering in December 1996. He was also commissioned through the New Mexico State University ROTC detachment in December 1996.

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14. ABSTRACT

GeoBEST is a software program designed to simplify the contingency beddown planning process through application of geographic information technology. The purpose of this thesis was to thoroughly evaluate GeoBEST using prospective GeoBEST users in a realistic beddown planning scenario. The Technology Acceptance Model (TAM) was applied, which measures a prospective user's perceptions of the technology's usefulness and ease-of-use and predicts their intentions to use the software in the future. The evaluation also included a qualitative evaluation of specific software features. The test group for this thesis was seventy-one Civil Engineering students attending contingency skills training at the Silver Flag training site, Tyndall AFB, FL. The students were given a one-hour interactive demonstration of GeoBEST after which they completed a survey. The students were given the option of using the program for preparation of their assigned beddown plan. The results from the TAM predict that the students were only slightly likely to use GeoBEST for beddown planning in the future. Throughout the course of the research, several features of GeoBEST were identified that limit the program's effectiveness. Some of these were minor irritants, while others were serious design flaws. Recommendations are made for implementation of GeoBEST and creation of training programs.

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